

SCREENING LEVEL RECONTAMINATION ANALYSIS FOR STORMWATER BASINS L AND M AT TERMINAL 4

25 April 2012

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1.0 INTRODUCTION

This report provides a screening level recontamination analysis for a portion of the Port of Portland's ("the Port") Terminal 4 on the Willamette River.

1.1 Summary of Willamette River Environmental Projects

Two major environmental projects are being implemented for the Willamette River. In 2000, the U.S. Environmental Protection Agency (USEPA) added the Portland Harbor Superfund Site (Superfund Site or Site) to the National Priorities List (NPL) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA or Superfund) (USEPA, 2001a). The Study area encompasses about 10 miles of the Willamette River in Portland, Oregon and includes the Terminal 4 facility. A draft Remedial Investigation (RI) Report (including a Human Health and Ecological Risk Assessment) was prepared on October 27, 2009 and a draft Feasibility Study (FS) report was submitted on March 30, 2012. The draft FS report identified a range of remedial alternatives and assessed their relative effect on environmental conditions in the river. The current schedule calls for EPA's Record of Decision (ROD) to be issued in 2014. Remedial design and implementation of remedial actions to address in-river sediments will begin after that time.

In 2005, the Oregon Department of Environmental Quality (DEQ) and EPA issued the Portland Harbor Joint Control Strategy (JSCS; DEQ and EPA, 2005). The document includes the following underlying principles:

- The JSCS represents a framework for making upland source control decisions at the Portland Harbor Superfund Site. All source control determinations are site specific based on facts determined through upland remedial investigations and the Portland Harbor RI/FS.
- The overarching goal of the JSCS is to identify, evaluate, and control sources of contamination that may reach the Willamette River, in a manner consistent with the objectives and schedule of the Portland Harbor RI/FS. Upland source control should be completed to the extent practicable prior to sediment cleanup in the Portland Harbor Superfund Site.
- Upland sources of contamination that adversely impact or have the potential to adversely impact the Willamette River, within the Portland Harbor Superfund Site, should be addressed in accordance with the MOU1 and the JSCS.
- DEQ is implementing a timeline by which, unless an upland facility is recalcitrant, the goal of screening, identifying, and evaluating sites needing source control should be complete by the time EPA issues the Portland Harbor ROD.

Under the JSCS, DEQ has been evaluating storm water discharges and working with facility operators to reduce loads discharging to the river. Consistent with the goals described above, the findings of the two programs will ultimately be combined to support implementation of remedial alternatives that would meet environmental goals in the river and that are protected from potential recontamination from on-going storm water discharges. Therefore, until the CERCLA environmental remedies and objectives become more clear (i.e. during the issuance of the Proposed Plan and ultimately the ROD), it is not possible to define the source control needed for stormwater to prevent recontamination of the river sediment remedy at any given site.

1.2 Terminal 4 Projects

The location and main features of Terminal 4 are shown in Figure 1-1.



Figure 1-1: Location and main features of the Terminal 4 Area.

Extensive work has been completed at Terminal 4. Uplands areas have been characterized, as reported in Terminal 4 Slip 1 RI Report (Ash Creek/Newfields, 2007), the Terminal 4 Slip 3 RI Report (Hart Crowser, 2000), the Terminal 4 Early Action Characterization Report (BBL, 2004), and the Terminal 4 Early Action Engineering Evaluation/Cost Analysis (EE/CA; BBL, 2005).

More recently Storm Water Source Control Measures (SCMs) and subsequent storm water sampling were performed at Terminal 4, pursuant to the following:

- Terminal 4 Slip 1 Upland Facility – Voluntary Agreement for Remedial Investigation, Source Control Measures, and Feasibility Study (DEQ No. LQVC-NWR-03-18), December 4, 2003.
- Terminal 4 Slip 3 Upland Facility – Consent Judgment No. 0410-10234, Multnomah Circuit Court, October 7, 2004, Section 3.C.

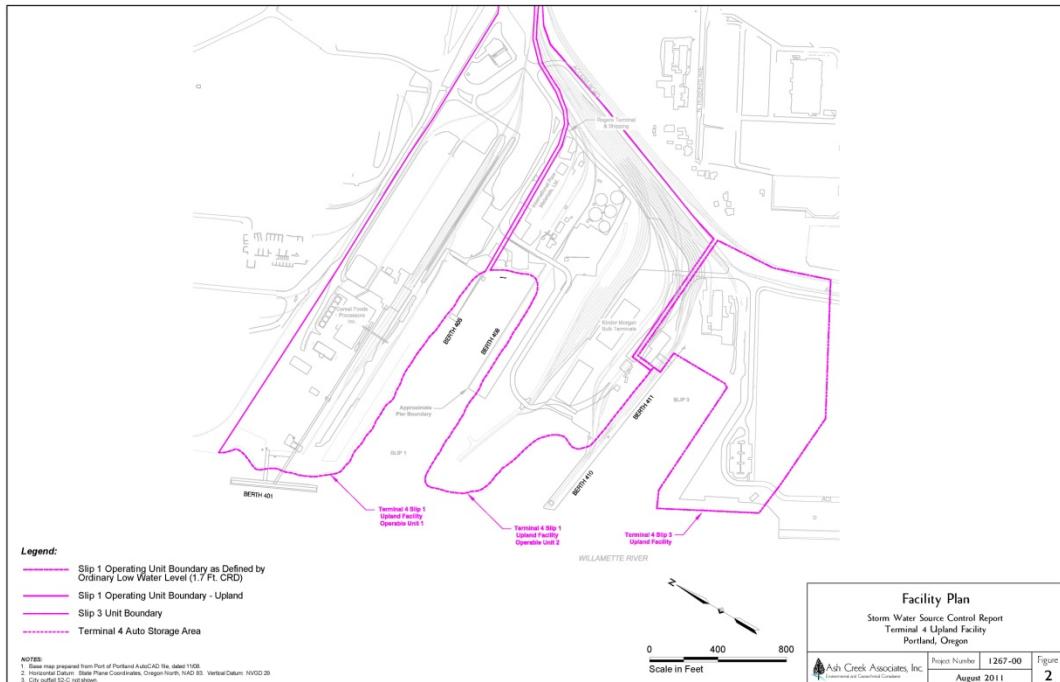


Figure 1-2: Upland Facility Boundary.

The storm water conveyance line cleanout SCMs were conducted in general accordance with the DEQ-approved Storm Water Source Control Evaluation (SWSCE). Storm water sampling was conducted between October 2010 and May 2011 to assess the storm water conditions following the SCMs. The results of the storm water SCMs and subsequent sampling were presented in the Storm Water Source Control Completion Report (Ash Creek, 2011).

In discussions on whether additional source controls or stormwater sampling would be needed, it was agreed that a screening level recontamination analysis would be performed to provide another line of evidence in the evaluation (DEQ, 2012). The Terminal 4 site is unique in the Portland Harbor in that as part of a Removal Action process, EPA approved a recontamination analysis approach (Sediment Recontamination Approach, Formation Environmental, 2010).

This report provides an initial recontamination evaluation using the approved approach, for a portion of the Terminal 4 area (stormwater drainage basins L and M) and a focused set of Contaminants of Interest (COIs) identified as being of primary concern in the storm water evaluation (PAHs and arsenic). Because the approach was approved for the removal action, terminology associated with that project is often used in this document and response actions that were planned in river areas are considered as likely remedial actions.

1.3 Report Structure

Section 2 of this report reviews the site conceptual model pertinent to potential for recontamination of river sediments from stormwater discharges from Basins M and L. Section 3 describes the overall methodology for the recontamination assessment and the data analysis performed to generate input parameters. The output from the recontamination analysis is discussed in Section 4. A brief sensitivity analysis is described in Section 5 and conclusions are presented in Section 6.

2.0 CONCEPTUAL SITE MODEL

The conceptual site model was described in detail in the *Sediment Recontamination Approach*. This section summarizes the details for stormwater basins L and M.

The Removal Action that was chosen for Terminal 4 consisted of a combination of MNR, capping and dredging, with dredged material being disposed of in a CDF to be built on site (Anchor QEA and NewFields, 2009). In order to evaluate recontamination, areas that were identified for different actions were evaluated separately. The Removal Action Area was subdivided into nine subareas for the recontamination analysis, as shown in Figure 2-1.

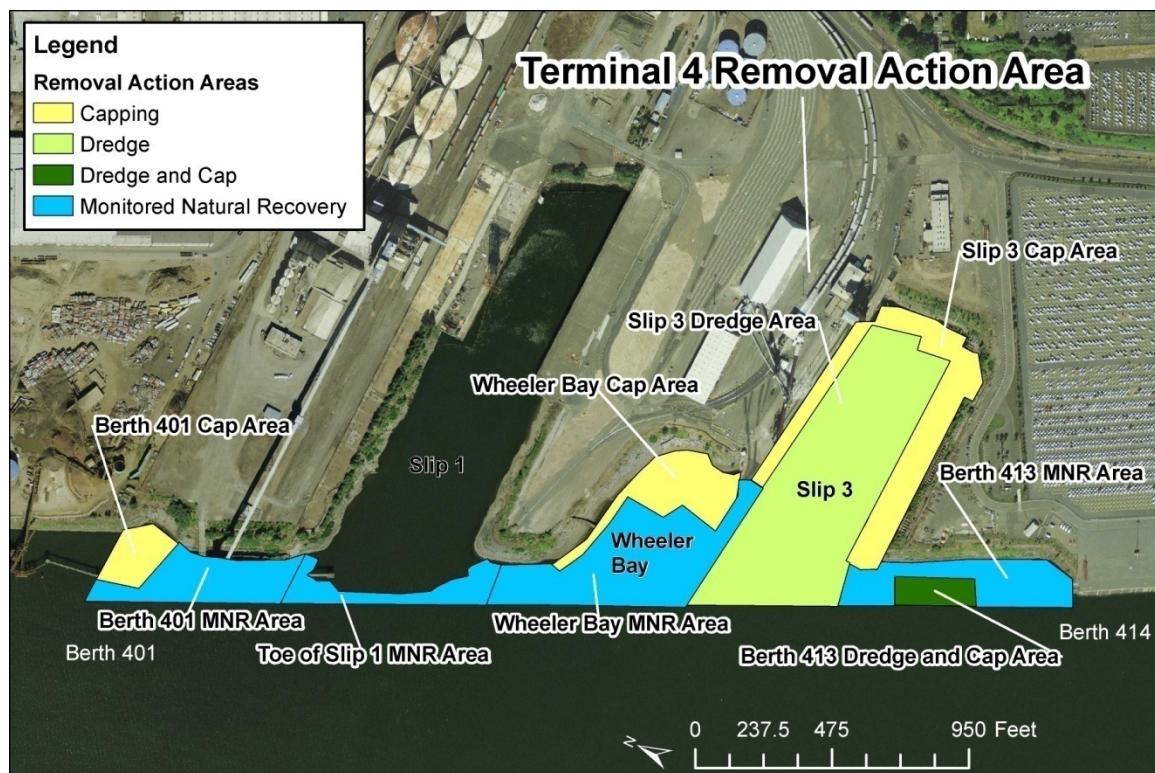


Figure 2-1: Phase II Removal Action sub-areas.

Stormwater discharges from Basins L and M have the potential to effect sediment conditions in three of these areas:

- Wheeler Bay Cap Area.
- Wheeler Bay MNR Area
- Toe of Slip 1 MNR Area

The conceptual model for each of these areas is described in the following subsections.

2.1 Wheeler Bay Cap Area

The Wheeler Bay cap area receives sediment from upstream and stormwater outfalls (Figure 2-2). The outfall for Basin L discharges to Wheeler Bay.

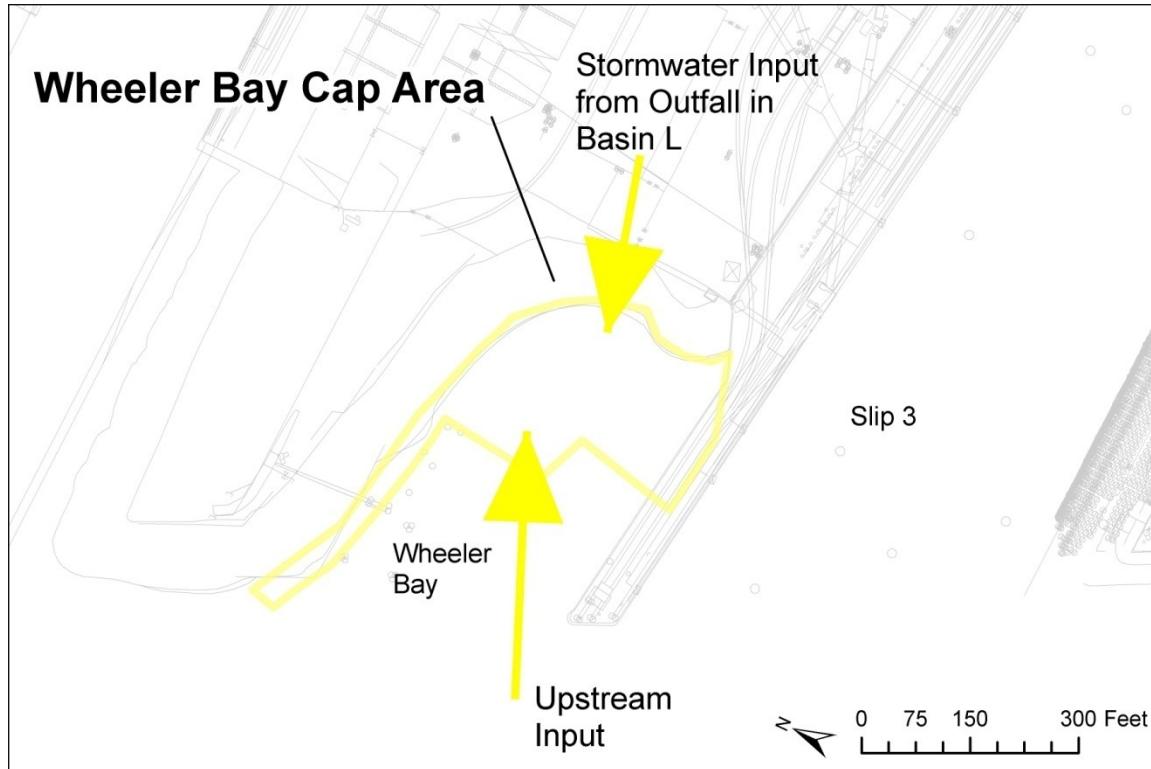


Figure 2-2: Wheeler Bay cap subarea and potential recontamination sources.

2.2 Wheeler Bay MNR Area

The Wheeler Bay MNR area receives sediment from upstream and stormwater from Basin L (Figure 2-3). This area includes all MNR areas downstream of the Slip 3 dredged area.

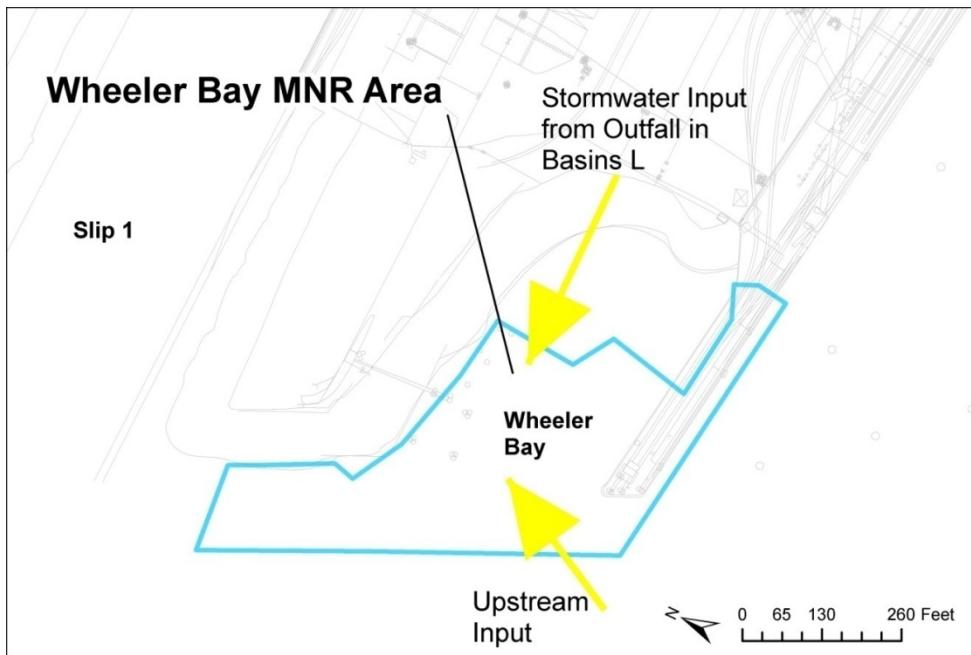


Figure 2-3: Wheeler Bay MNR subarea and potential recontamination sources.

2.3 Toe of Slip 1 MNR Area

The toe of slip 1 MNR area extends across the mouth of slip 1 (Figure 2-4). This area will receive sediment input from upstream and stormwater from Basin M.

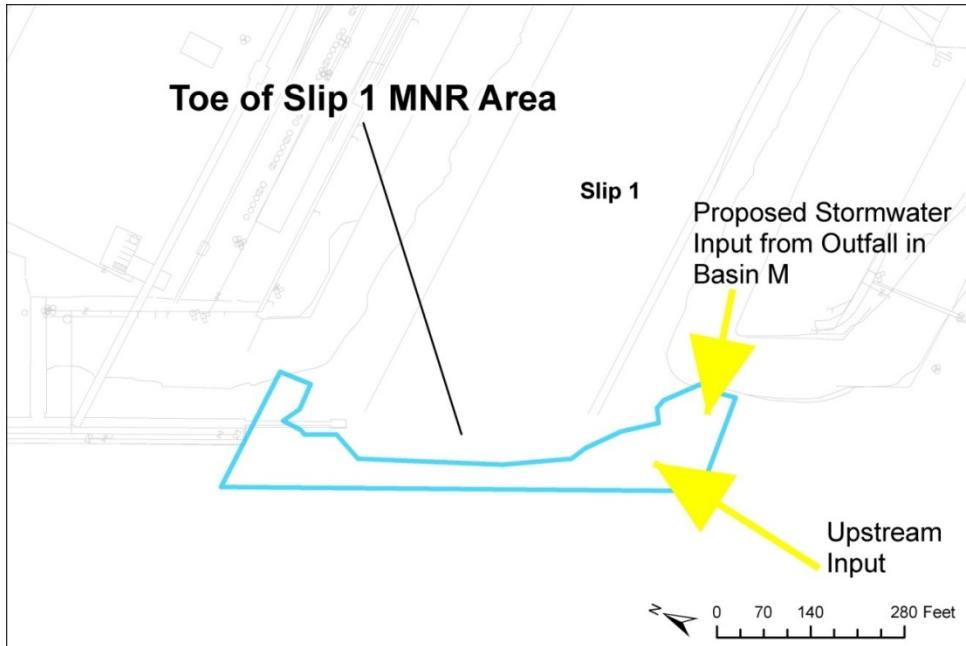


Figure 2-4: Toe of Slip 1 MNR subarea and potential recontamination sources.

3.0 RECONTAMINATION ANALYSIS METHODOLOGY AND INPUT DATA

The overall methodology for assessing sediment recontamination potential is described in the *Sediment Recontamination Approach* report and summarized in the following sections, including the equations used in the calculation of predicted COI concentrations in surface sediments in the future.

COIs for sediment at Terminal 4 are naturally hydrophobic, causing the majority of the mass to be sorbed to sediment rather than in dissolved phase. COIs are primarily sorbed to solids not only at the site, but also upstream. Desorption of COIs from suspended sediments in stormwater or in the upstream river to the dissolved phase is possible. However, once in the dissolved phase, the concentration gradient between bed sediment and dissolved phase is always from sediment to water and net transport to the sediments is not possible. Therefore the focus of the analysis is on COIs present on sediment, either suspended in discharging stormwater, suspended in river water or present as the riverbed in the local areas of interest.

3.1 Overall Approach

The overall recontamination approach consists of using the mathematical model, SEDCAM, to predict COI concentrations in surface sediments over time, considering sediment accumulation, mixing, and contaminant degradation (Jacobs et al., 1988). Source inputs and predicted concentrations over time depend on the assumption of complete mixing within the River Sediment Subarea; however, the recontamination analysis was conducted on a point-by-point basis. The required inputs to the SEDCAM model were initial COI concentrations in surface sediment, estimated sediment and COI loads from primary sources, estimated degradation rates for each COI, and an assumed thickness of sediment mixing.

3.2 SEDCAM Recontamination Model for River Sediment Subareas

The SEDCAM model (Figure 3-1) was chosen for the Terminal 4 Recontamination Analysis because it is a conservative and simple model. Based on the level of detail of available data, a more complex model is not expected to yield more accurate results. The SEDCAM model is easy to implement and provides a quantitative estimate of many physical processes occurring at the site (LWG, 2005).

The model contains several simplifying assumptions or limitations, such as a well-mixed surface sediment layer of defined thickness and a single term covering both chemical degradation and diffusion. It also does not consider advection of pore water explicitly. However, the relative simplicity of the model is one of its main strengths.

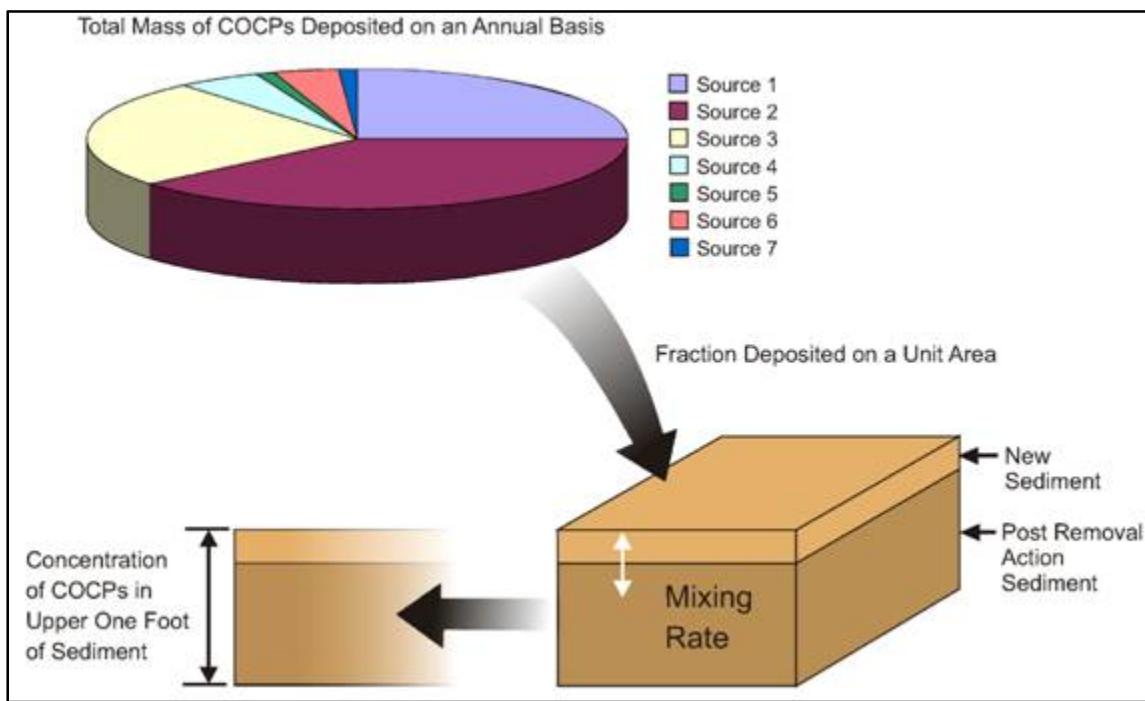


Figure 3-1: Schematic explaining the SEDCAM model.

The form of the SEDCAM model equation used in this analysis is:

$$C_c(t) = \frac{1}{(1+kTs)} C_p \left[1 - e^{\frac{-(1+kTs)t}{Ts}} \right] + C_o e^{\frac{-(1+kTs)t}{Ts}}$$

$$Ts = ML/Rs$$

where:

$C_c(t)$ = concentration of COI in surface sediment (mixed layer) at time t (mg/kg or $\mu\text{g}/\text{kg}$)

C_p = average concentration of COI in particles being deposited on the sediment (mg/kg or $\mu\text{g}/\text{kg}$)

C_o = average concentration of COI in surface sediment (mixed layer) at time zero (i.e., immediately after response activities are completed) (mg/kg or $\mu\text{g}/\text{kg}$)

ML = thickness of mixed layer (cm)

Rs = sedimentation rate (cm/year)

C_p represents the average COI concentration in new particles deposited on the sediment. The mass of COI in particles being deposited on the sediment (M_p) is related to concentration (C_p) as follows:

$$M_p = C_p M_s$$

where C_p = Average COI concentration on sediment particles

M_s = Mass of sediment particles deposited.

Further

$$C_p = \sum C_i M_i / \sum M_i$$

where C_i = COI concentration on sediment particles from source "i" (mg/kg)

M_i = mass of sediment particles from source "i" (kg)

and $\sum C_i M_i$ is therefore the sum of particulate-based COI load (COI concentration on the particulate multiplied by mass of particulate) for all sources (i.e., individual stormwater upstream sources, etc.)

The sediment mass input to the system is equal to the sum of all inputs (i.e., $M_s = \sum M_i$) and further for an individual area, the sum of the sediment particle inputs must balance with the total sedimentation rate, such that

$$M_s = R_s A_{dep} \rho_b$$

3.3 Stormwater Data Analysis

As discussed in Section 1, this screening-level analysis was prepared to assist with evaluation of comments made by DEQ on levels of PAHs and arsenic in stormwater discharging from basins L and M.

A key element of this analysis is the normalization of COI concentrations on suspended sediment, rather than total concentrations in the stormwater. The COIs are hydrophobic and therefore would be expected to be primarily associated with suspended solids. While there is often variability in total concentrations in stormwater, this normalization can provide clarity with regard to the characteristics of the stormwater discharge. It is also consistent with this analysis of the potential recontamination of river sediment.

3.3.1 Screening of PAH Data

The first step in the analysis was to evaluate the PAH data to identify a subset of compounds to be used in the analysis. The stormwater PAH data are shown in Table 3-1. Four compounds were measured at maximum concentrations over two hundred times the JSCS screening level in Basin L stormwater prior to the storm water line cleanouts. These compounds were also the most elevated above screening levels in Basin M stormwater. These compounds were therefore selected to provide a focus for the screening-level recontamination analysis for PAHs.

Table 3-1: Storm water analytical results: Polycyclic Aromatic Hydrocarbons

Monitoring Location	Date Sampled	TSS	Naphthalene		2-Methylnaphthalene		Acenaphthylene		Acenaphthene		Dibenzofuran		Fluorene		Phenanthrene		Anthracene		Fluoranthene			
			Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved		
			(mg/L)	Concentrations in µg/L (ppb)																		
Basin L	3/24/2007	108	0.14	0.056	0.27	0.088	0.032	0.021	0.200	0.013 J	--	--	0.15	0.018 J	1.4	0.055	0.20	0.017 J	3.0	0.097		
Basin L	5/3/2007	207	0.11	0.10	0.16	0.16	0.029	0.022 J3	0.18	0.13	0.11	0.09	0.16	0.13	1.6	1.3	0.18	0.11	2.8	2.0		
Basin L	5/20/2007	309	0.085	0.032	0.039	0.015 J	0.013 J	0.0073 J	0.28	0.057	0.087	0.03	0.12	0.032	1.9	0.63	0.26	0.065	4.6	1.3		
Basin L	9/28/2007	80	0.058	--	0.024	--	0.0088 J	--	0.062	--	--	--	0.034	--	0.73	--	0.062	--	1.5	--		
Basin L	10/23/2010	7	0.029	0.031 R	0.018	0.015 R	0.027	0.029 R	0.025	0.013 J R	--	--	0.035	0.025 R	0.28	0.022 R	0.18	0.18 R	0.54	0.030 R		
Basin L	11/6/2010	28	0.023 J3	0.019 J3 R	0.019	0.013 J R	0.0058 J	0.016	0.015 R	0.011 J R	--	--	0.016	0.010 J R	0.12	0.03 R	0.05	0.06 R	0.19	0.026 R		
Basin L	2/12/2011	10	0.046 J3	0.018 J3 R	0.037 J3	0.014 J3 R	J3	J3 R	0.019	0.010 J R	--	--	0.022 J3	R	0.29	0.046 J3 R	0.025	0.015 R	0.42	0.02 J3 R		
Basin M	3/24/2007	117	0.059	0.031 J3	0.069	0.024	0.084	0.054	0.22	0.067	--	--	0.12	0.038	0.35	0.10	0.19	0.072	1.4	0.53		
Basin M	4/7/2007	35	0.018 J	0.017 J	0.019 J	0.017 J	0.035	0.058	0.032	0.028	--	--	0.025	0.026	0.11 J2	0.10	0.091	0.10	0.27	0.28		
Basin M	5/3/2007	66	0.017 J J3	0.016 J J3	J3	J3	0.0054 J	0.0063 J	0.022 J3	0.022 J3	0.0083 J	0.0097 J	J3	0.014 J J3	0.014 J J3	0.095	0.12	0.066	0.067	0.18	0.27	
Basin M	9/28/2007	39	0.02 J3	--	0.017 J J3	--	0.0075 J	--	0.0066 J	--	0.024	--	--	--	0.013 J	--	0.085	--	0.059	--	0.19	--
Basin M	10/23/2010	4	0.010 J	<0.012 R	0.012 J R	<0.012 R	0.033	0.024 R	0.017	0.016 R	--	--	0.011 J	0.0046 J R	0.031	0.010 J R	0.16	0.18 R	0.096	0.024 R		
Basin M	11/6/2010	<1	0.016 J3	0.018 J3 R	0.013 J	0.014 R	0.044	0.032 R	0.014 J	0.0085 J R	--	--	0.0080 J	0.0047 J R	0.049	0.023 R	0.15	0.14 R	0.14	0.066 R		
Basin M	2/12/2011	9	0.057 J3	0.015 J3 R	0.066	<0.012 R	0.1	0.031 R	0.093	0.018 R	--	--	0.077	0.016 J3 R	0.27	0.047 J3R	0.21	0.074 R	0.80	0.17 R		
Applicable JSCS Screening Level Value		NA	0.2	0.2	0.2	0.2	0.2	0.2	0.2	NA	NA	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2		

Please refer to notes at
end of table.

Table 3-1: Storm water analytical results: Polycyclic Aromatic Hydrocarbons (Continued)

Monitoring Location	Date Sampled	TSS (mg/L)	Pyrene		Benz(a)anthracene		Chrysene		Benzo(b)fluoranthene		Benzo(k)fluoranthene		Benzo(a)pyrene		Indeno(1,2,3-cd)pyrene		Dibenz(a,h)anthracene		Benzo(g,h,i)perylene	
			Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
			Concentrations in µg/L (ppb)																	
Basin L	3/24/2007	108	2.7	0.08	1.6	0.048	2.5	0.087	3.4	0.11	1.2	0.04	2.2	0.05	2.7	0.063	0.54	0.014 J	2.5	0.069
Basin L	5/3/2007	207	2.4	1.6	1.3	0.80	1.7	1.1	3.0	2.0	0.98	0.65	2.0 J6	1.3 J6	2.5	1.7	0.56	0.36	2.5	1.7
Basin L	5/20/2007	309	3.9	1.1	2.7	0.58	3.8	1.1	5.5	1.4	1.9	0.5	3.7	0.86	3.8	0.93	0.84	0.18	3.5	0.91
Basin L	9/28/2007	80	1.0	--	0.57	--	1.0	--	1.5	--	0.44	--	0.87	--	0.97	--	0.21	--	0.87	--
Basin L	10/23/2010	7	0.51	0.03 R	0.18	0.012 J R	0.56	0.035 R	0.64	0.034 R	0.42	0.022 R	0.36	0.013 J R	0.37	0.023 R	0.13	0.0086 J R	0.47	0.044 R
Basin L	11/6/2010	28	0.18	0.029 R	0.051	0.0097 J R	0.19	0.027 R	0.19	0.026 R	0.13	0.014 R	0.079	0.010 J R	0.098	0.013 J R	0.034	0.0028 J R	0.13	0.021 R
Basin L	2/12/2011	10	0.36	0.015 J3 R	0.12	0.0032 J R	0.36	0.015 R	0.34	0.016R	0.27	0.0072 J R	0.21	<0.00066 R	0.2	0.0095 J R	0.061	0.0042 J R	0.25	0.012 J R
Basin M	3/24/2007	117	1.2	0.41	0.5	0.2	0.46	0.17	0.57	0.25	0.18	0.079	0.36	0.15	0.30	0.12	0.068	0.024	0.32	0.12
Basin M	4/7/2007	35	0.25	0.25	0.15	0.17	0.13	0.13	0.28	0.39	0.092	0.12	0.19	0.27	0.18	0.31	0.038	0.061	0.20	0.33
Basin M	5/3/2007	66	0.16	0.25	0.096	0.14	0.091	0.15	0.20	0.30	0.066	0.10	0.15 J6	0.23 J6	0.19	0.26	0.041	0.058	0.23	0.29
Basin M	9/28/2007	39	0.14	--	0.062	--	0.077	--	0.12	--	0.037	--	0.072	--	0.08	--	0.018 J	--	0.071	--
Basin M	10/23/2010	4	0.10	0.021 R	0.056	0.022 R	0.11	0.034 R	0.17	0.057 R	0.13	0.043 R	0.15	0.066 R	0.16	0.051 R	0.085	0.025 R	0.26	0.098 R
Basin M	11/6/2010	<1	0.16	0.073 R	0.087	0.042 R	0.26	0.10 R	0.47	0.17 R	0.28	0.090 R	0.41	0.12 R	0.27	0.084 R	0.13	0.038 R	0.42	0.15 R
Basin M	2/12/2011	9	0.71	0.15 R	0.45	0.11R	0.63	0.14 R	0.72	0.17R	0.58	0.12 R	0.61	0.14 R	0.36	0.076 R	0.15	0.027R	0.45	0.097 R
Applicable JSCS Screening Level Value		NA	0.2	0.2	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.2	0.2	

Notes:

1. Polynuclear Aromatic Hydrocarbons by EPA Method 8270 C SIM.
2. µg/L (ppb) = Micrograms per liter (parts per billion).
3. Screening levels used taken from Portland Harbor Joint Source Control Strategy Table 3-1: Screening Level values for Soil/Stormwater Sediment, Stormwater, Groundwater, and Surface Water (7/16/07 Revision).
4. **Bolded** value indicates concentration exceeds applicable screening level value.
5. J = The result is an estimated concentration that is below the Method Reporting Limit (MRL) and above the Method Detection Limit (MDL).
6. J2 = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample. The precision goal of 30% was exceeded for this analyte by the results of the field duplicate sample or the lab duplicate.
7. J3 = The detected concentration of this analyte is equal to or less than 5 times the concentration detected in the method blank.
8. J6 = The laboratory control sample/laboratory control sample duplicate (LCS/LCSD) recovery for this analyte exceeded the control criteria.
9. R = The data are rejected due to deficiencies in the ability to analyze the sample and meet quality control criteria.
10. Shading indicates that the data have been rejected.
11. Filtration methods used for the dissolved analyses of samples collected on October 23, 2010 and November 6, 2010 were incorrect. The filter used was larger than specified in LWG protocols and the dissolved concentrations are likely biased high.
12. mg/L = milligrams per liter
13. TSS = total suspended solids by EPA Method 160.2 or SM 2540D.

3.3.2 Evaluation of PAH Concentrations in Stormwater

The relationship between total COI concentrations in stormwater relative to TSS concentrations was evaluated, as shown in the following figures.

3.3.2.1 Basin L

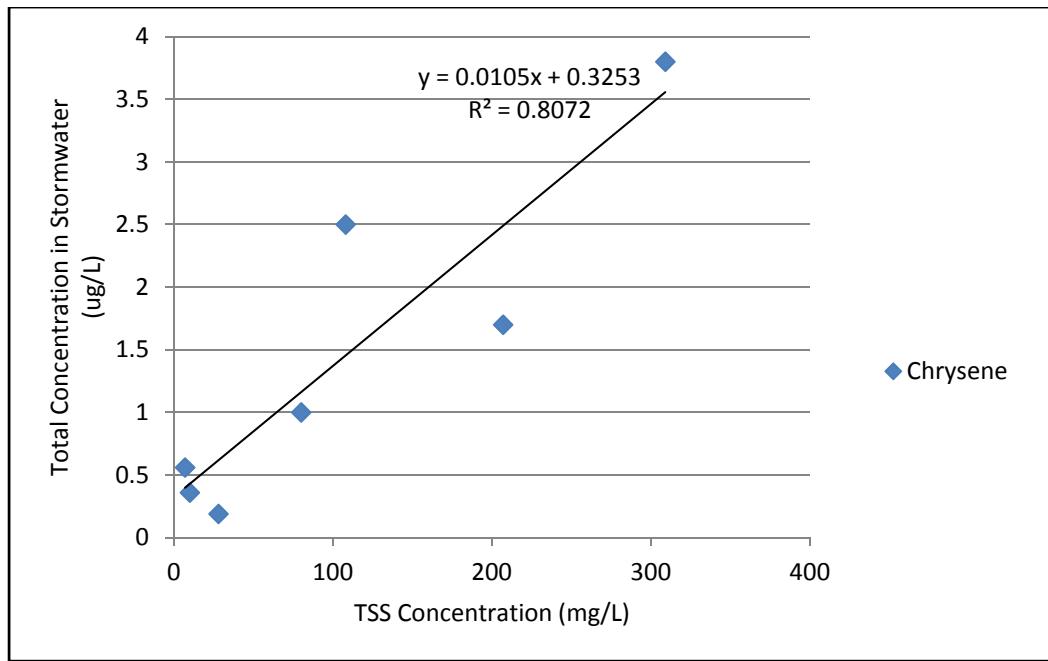


Figure 3-2: Relationship between total Chrysene concentrations and TSS concentrations in Basin L stormwater.

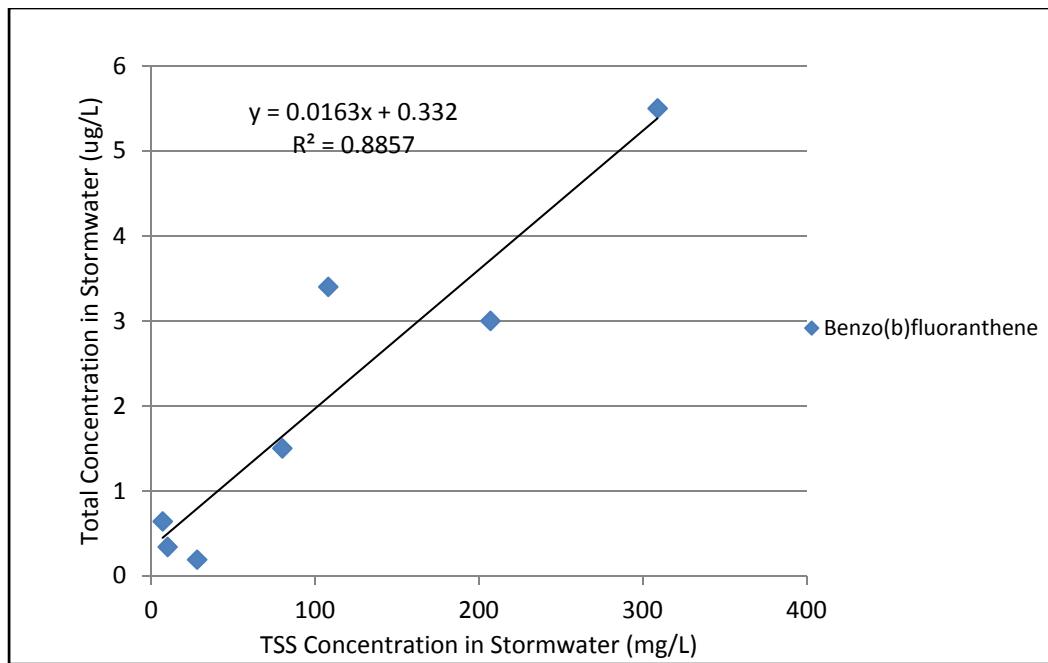


Figure 3-3: Relationship between total Benzo(b)fluoranthene concentrations and TSS concentrations in Basin L stormwater.

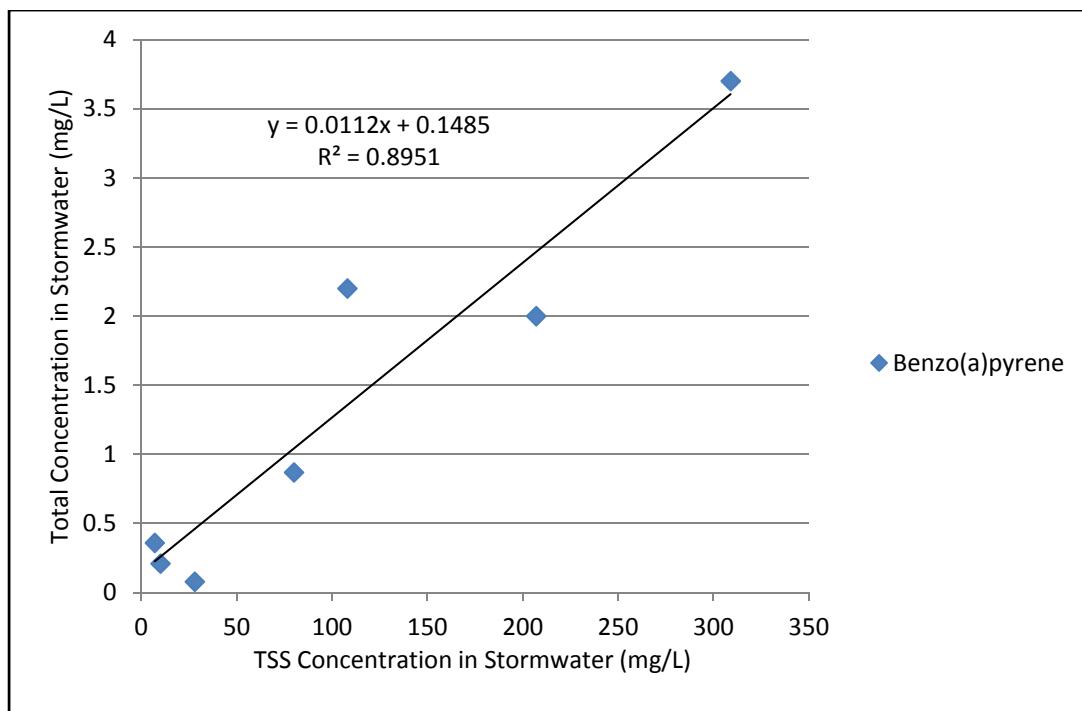


Figure 3-4: Relationship between total Benzo(a)pyrene concentrations and TSS concentrations in Basin L stormwater.

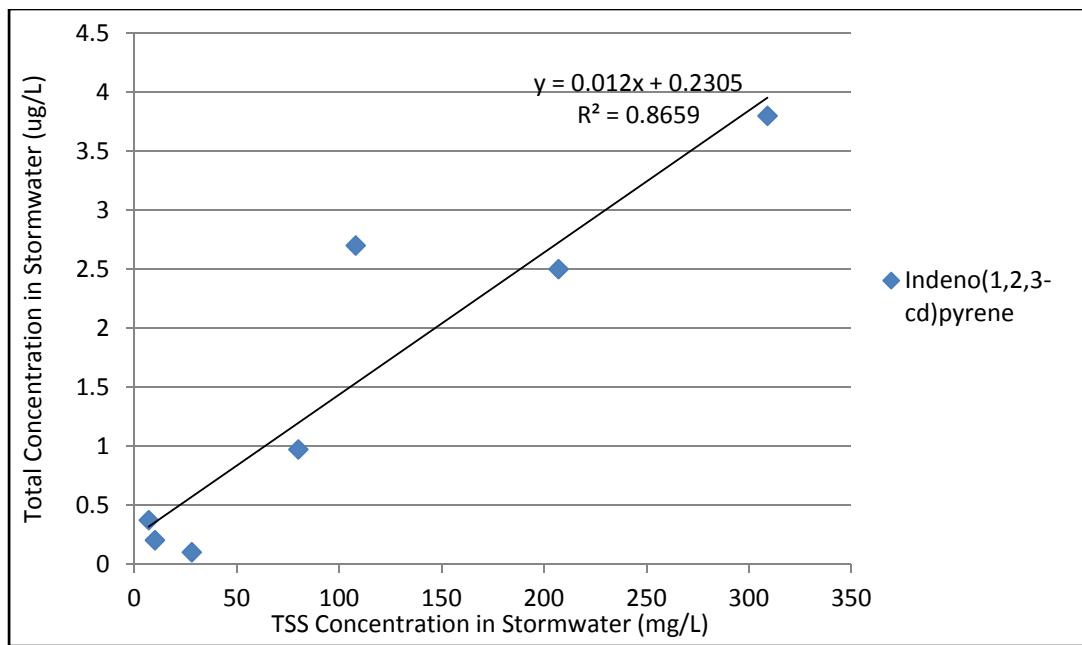


Figure 3-5: Relationship between total Indeno(1,2,3-cd)pyrene concentrations and TSS concentrations in Basin L stormwater.

As shown, all PAH compounds are strongly correlated to TSS concentration. This analysis uses the entire dataset, including both the composite samples collected in 2007 and grab samples collected in 2010 and 2011. This indicates that the solids suspended in stormwater have generally the same PAH levels in all storm samples.

The slope of the correlation allows for calculation of the average PAH concentration on the suspended solids:

$$\text{PAH Concentration on Solids (mg/Kg)} = \text{Slope (ug PAH/mg TSS)} \times 1000$$

The estimated average concentrations are shown in Table 3-2. These values are used in the recontamination analysis.

Table 3-2: PAH COI concentrations on suspended stormwater solids for Basin L

PAH	Estimated Concentration on Suspended Stormwater Solids (mg/Kg)
Chrysene	10.5
Benzo(b)fluoranthene	16.3
Benzo(a)pyrene	11.2
Indeno(1,2,3-cd)pyrene	12

3.3.2.2 Basin M

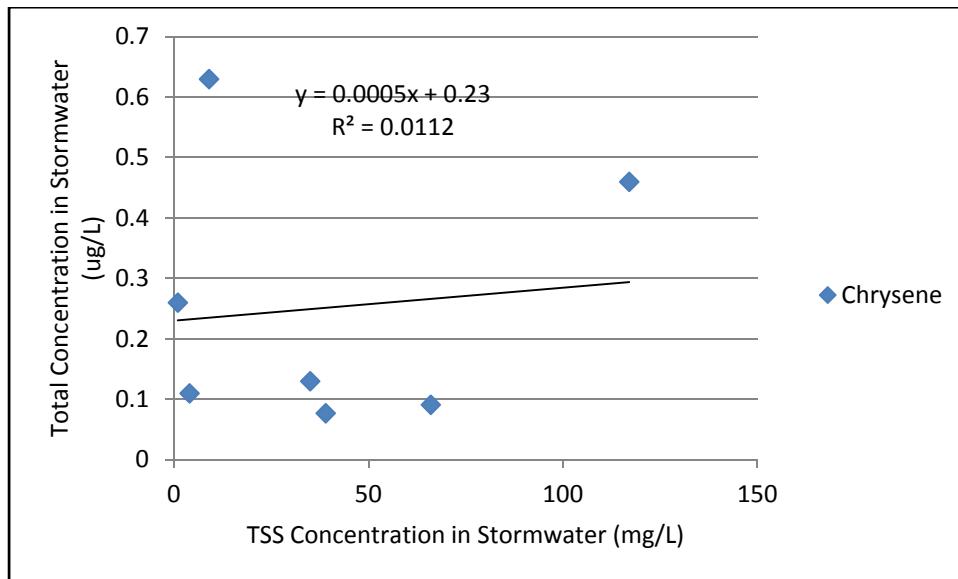


Figure 3-6: Relationship between total Chrysene concentrations and TSS concentrations in Basin M stormwater (all data).

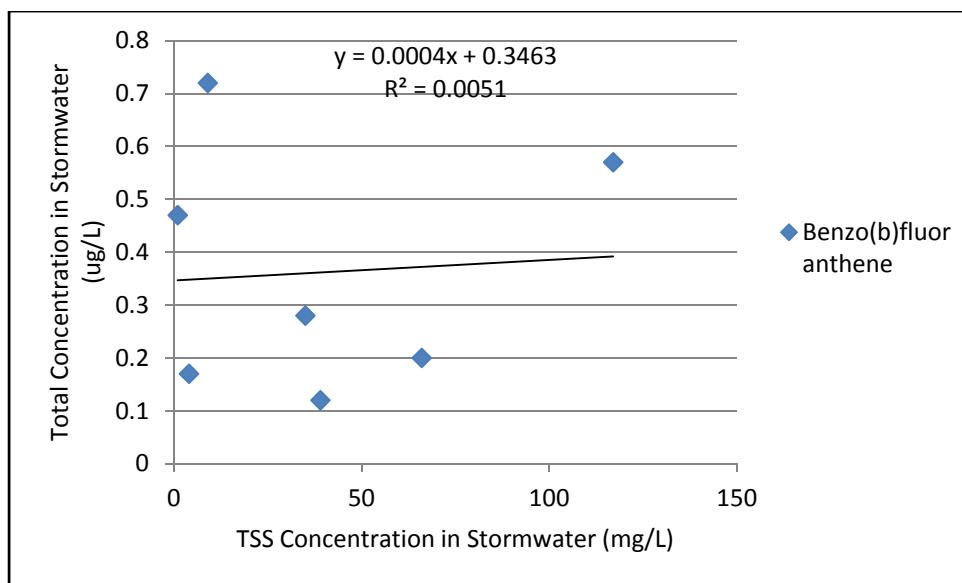


Figure 3-7: Relationship between total Benzo(b)fluoranthene concentrations and TSS concentrations in Basin M stormwater (all data).

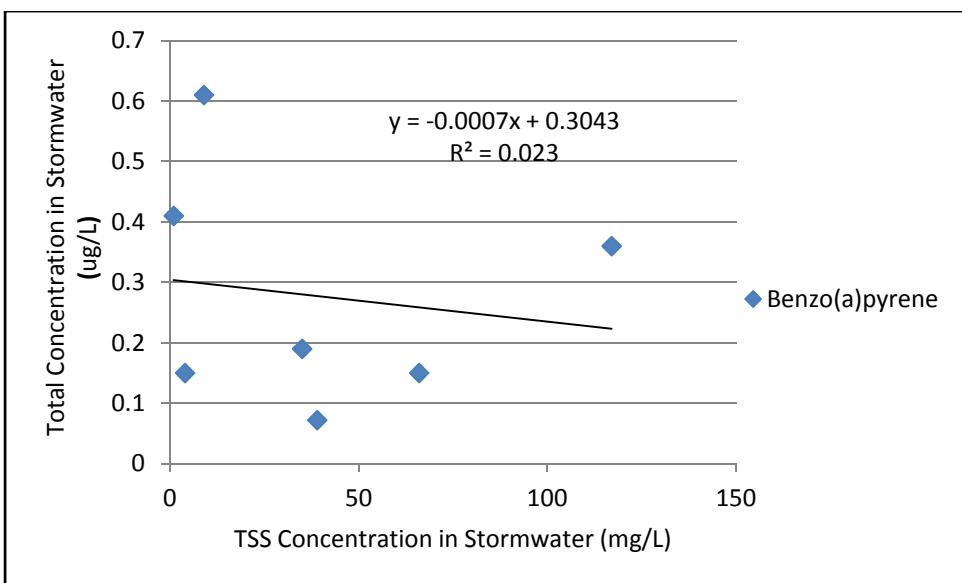


Figure 3-8: Relationship between total Benzo(a)pyrene concentrations and TSS concentrations in Basin M stormwater (all data).

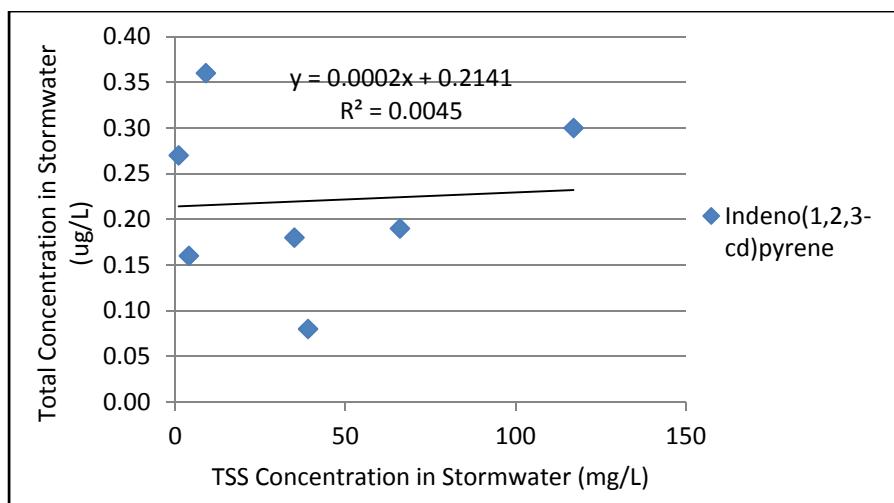


Figure 3-9: Relationship between total Indeno(1,2,3-cd)pyrene concentrations and TSS concentrations in Basin M stormwater (all data).

As shown, when the entire dataset are considered, there is no correlation between PAH concentration and TSS for any of the COIs. Basin M has a stormwater treatment system that removes solids from stormwater up to its design flow. Samples in 2010 and 2011 were collected near the start of the storms when treatment would be expected to have maximum effectiveness in removing suspended solids. The 2007 sampling consisted of composite sampling covering greater periods of the storm, where the treatment system could have lesser cumulative effect (i.e. sampling includes the period after its flow capacity was exceeded). Revising the analysis to consider only the 2007 composite sampling events yields a better correlation as shown in the following figures.

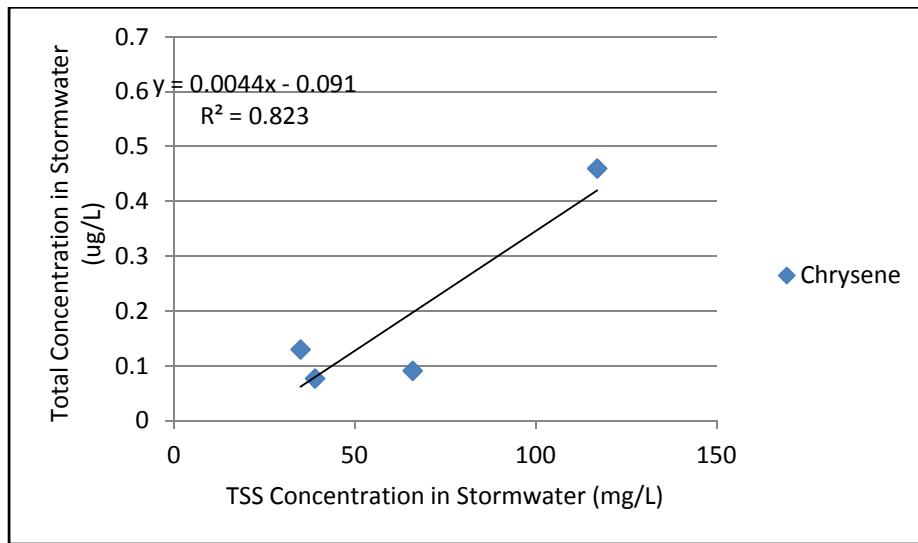


Figure 3-10: Relationship between total Chrysene concentrations and TSS concentrations in Basin M stormwater (composite sampling data only).

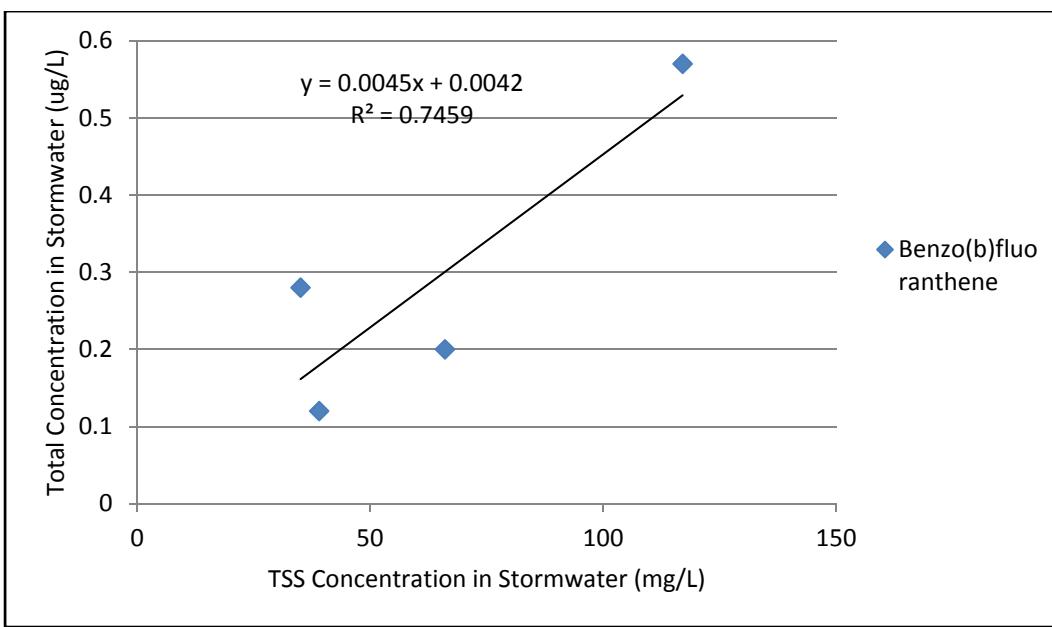


Figure 3-11: Relationship between total Benzo(b)fluoranthene concentrations and TSS concentrations in Basin M stormwater (composite sampling data only).

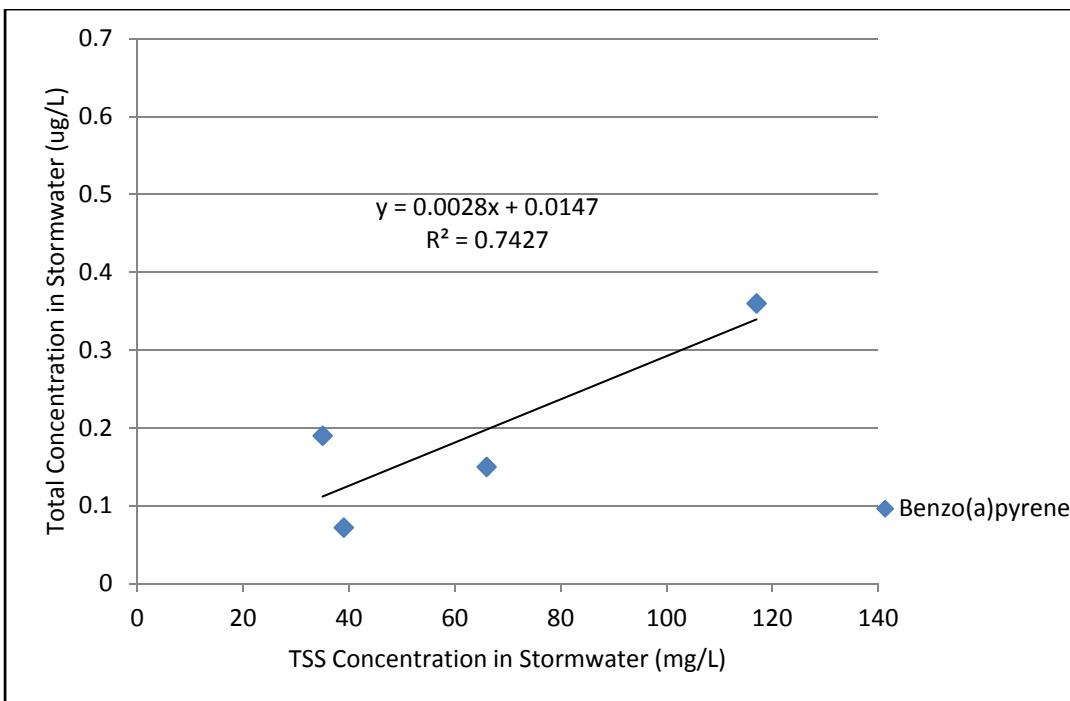


Figure 3-12: Relationship between total Benzo(a)pyrene concentrations and TSS concentrations in Basin M stormwater (composite sampling data only).

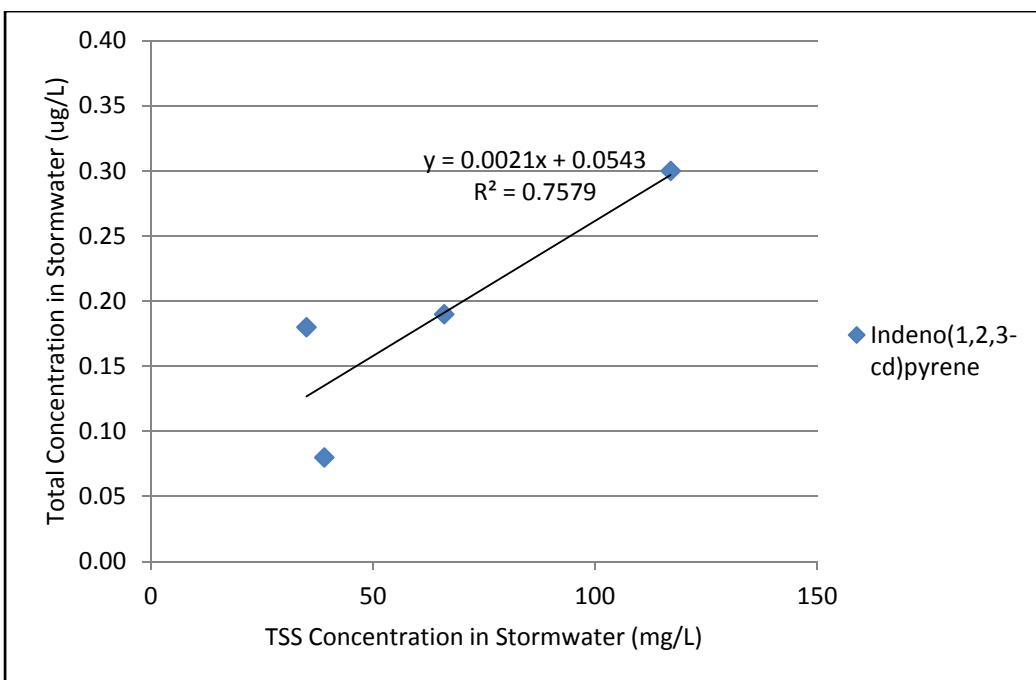


Figure 3-13: Relationship between total Indeno(1,2,3-cd)pyrene concentrations and TSS concentrations in Basin M stormwater (composite sampling data only).

Using the same calculation as shown above for Basin L, the estimated average concentrations of PAHs on suspended solids in stormwater from Basin M are shown in Table 3-3. These values are used in the recontamination analysis.

Table 3-3: PAH COI concentrations on suspended stormwater solids for Basin M.

PAH	Estimated Concentration on Suspended Stormwater Solids (mg/Kg)
Chrysene	4.4
Benzo(b)fluoranthene	4.5
Benzo(a)pyrene	2.8
Indeno(1,2,3-cd)pyrene	2.1

3.3.3 Evaluation of Arsenic Concentrations in Stormwater

The arsenic concentrations measured in stormwater for basins M and L are shown in Table 3-4.

Table 3-4: Arsenic concentrations measured in stormwater from Basin L and M.

Monitoring Location	Date Sampled	TSS (mg/L)	Arsenic	
			Total	Dissolved
Basin L	3/24/2007	108	0.803	0.898
	5/3/2007	207	0.25	0.22 R
	5/20/2007	309	1.64	2.38
	9/28/2007	80	1.07	1.34
	10/23/2010	7	5	5.7 R
	11/6/2010	28	3.7	3.8 R
	2/12/2011	10	0.95	0.91
Basin M	3/24/2007	117	3.67	3
	5/3/2007	66	3.27	3.16
	5/20/2007	--	3.39	2.95
	9/28/2007	39	2.32	2.03
	10/23/2010	4	15.8	14.8 R
	11/6/2010	<1	6.9	7.1 R
	2/12/2011	9	3.3	1.3
Applicable JSCS Screening Level Value			0.045	0.045

The relationship between total arsenic concentration and TSS in stormwater samples for all samples is shown in the following figures. As shown there is little correlation between the two parameters.

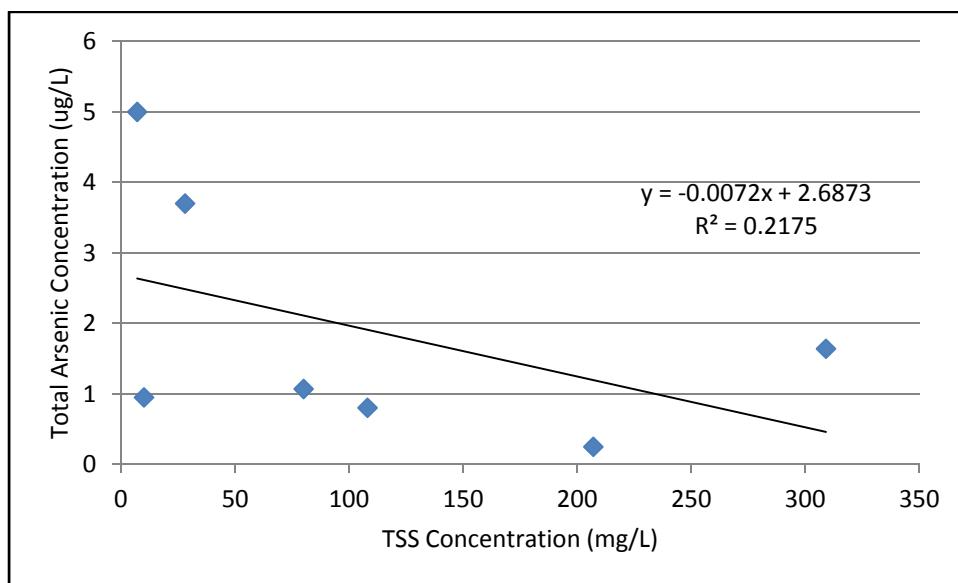


Figure 3-14: Relationship between total Arsenic concentrations and TSS concentrations in Basin L stormwater (all data).

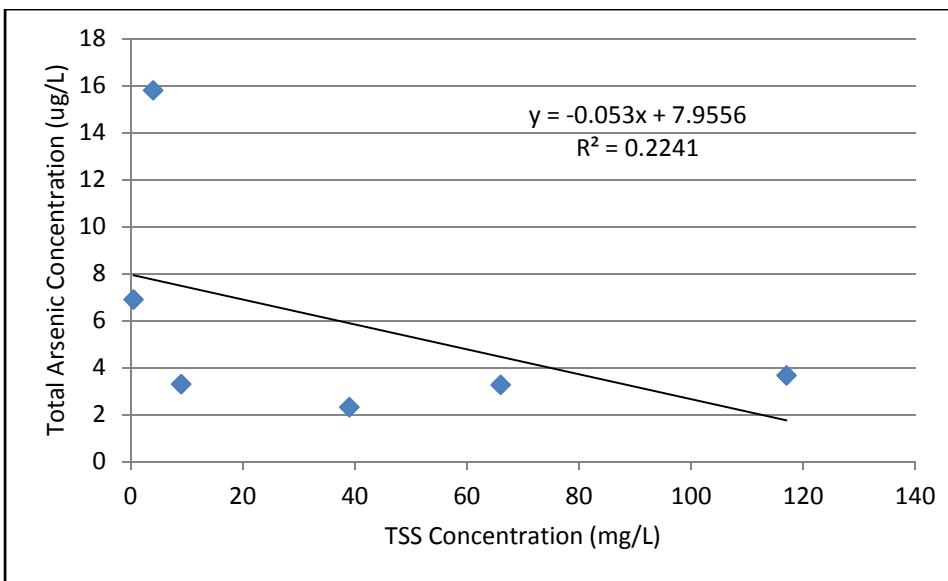


Figure 3-15: Relationship between total Arsenic concentrations and TSS concentrations in Basin M stormwater (all data).

The analysis is reproduced below using only the data from the composite sampling performed in 2007.

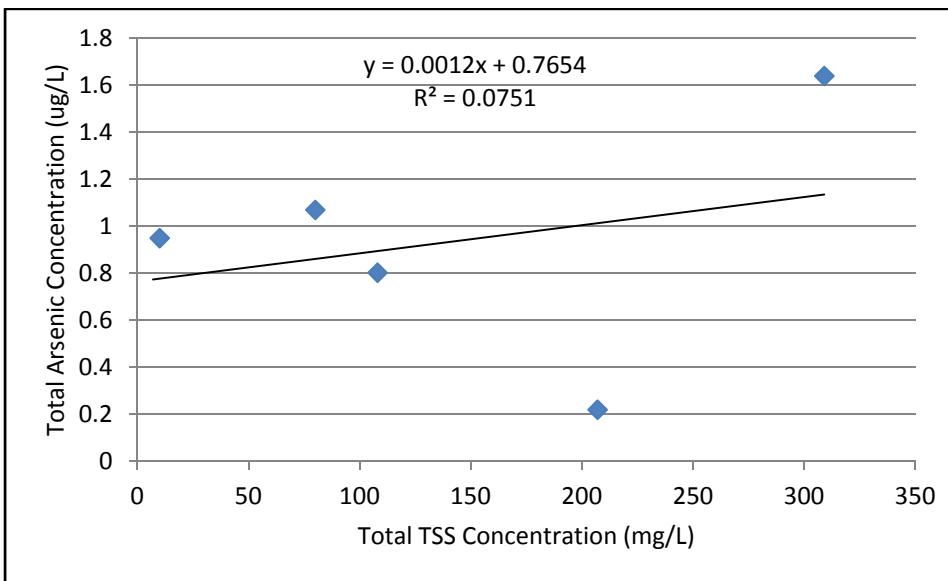


Figure 3-16: Relationship between total Arsenic concentrations and TSS concentrations in Basin L stormwater (composite data only).

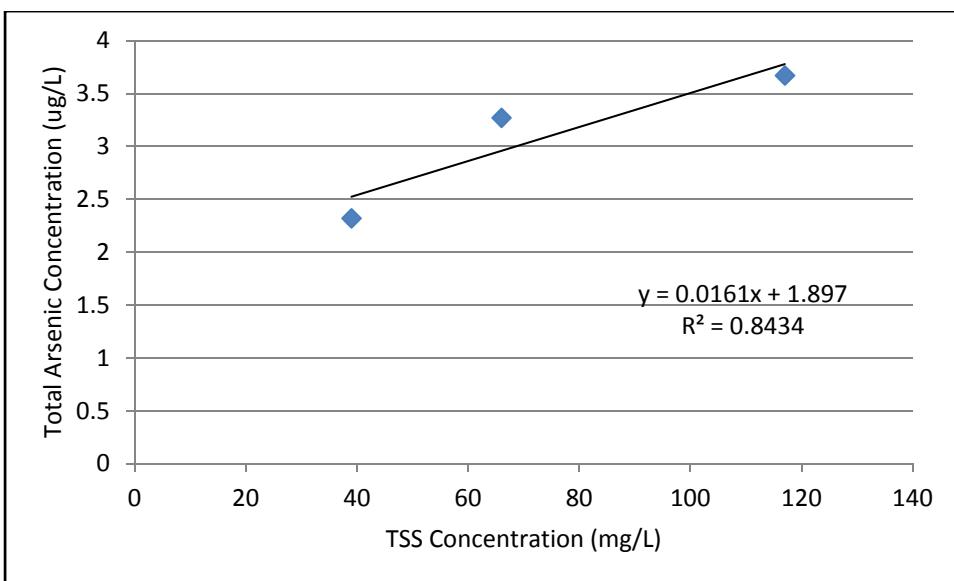


Figure 3-17: Relationship between total Arsenic concentrations and TSS concentrations in Basin M stormwater (composite data only).

The average arsenic concentration on stormwater solids was then estimated from the slope of the linear correlation, as shown in Table 3-5. As noted above, the 2007 composite sampling covered greater periods of each storm and provide data more representative of average conditions.

Table 3-5: Average Arsenic concentrations on suspended stormwater solids for Basins L and M.

Basin	Estimated Arsenic Concentration on Suspended Stormwater Solids (mg/Kg)
L	1.2
M	16.1

3.3.4 Stormwater Suspended Solids Concentration

The average TSS concentration was estimated from the composite sampling data shown in Table 3-1, yielding the values shown below. These data were generated prior to the stormwater line cleanouts and are therefore expected to be conservative (high) relative to current conditions.

Table 3-6: Average TSS concentrations in stormwater from Basins L and M.

Basin	Average TSS Concentration (mg/L)
L	176
M	64

3.3.5 Average Annual COI Loads on Suspended Solids in Stormwater

The SIMPLE method (Schueler, 1987) is the runoff model being used in the harborwide RI/FS for Portland Harbor (LWG, 2009). It is described in detail in the Stormwater Loading Calculation Methods (Anchor, 2009). The SIMPLE method modifies the volume of water produced by rainfall events by a runoff coefficient and a fraction of annual rainfall that produces runoff. The runoff coefficient takes the surface cover type into account (i.e. fraction that is impervious).

Runoff was calculated as follows:

$$RO = R * R_v * 0.9$$

where R is the annual rainfall, R_v is the runoff coefficient, and 0.9 is a standard factor representing the percentage of rainfall that produced runoff. Annual rainfall was measured by the Portland HYDRA network data. The average annual rainfall from the 50th percentile flow year, 2002 (35.02 in/yr), was used in the loading calculation (Anchor QEA, 2009). The land cover impervious fraction is estimated in the Removal Action Area EE/CA (BBL, 2005). Basin areas were provided in the Final Terminal 4 Slips 1 and 3 Stormwater Data Summary Report (Ash Creek and NewFields, 2009).

The runoff coefficient can be described as:

$$R_v = 0.05 + 0.9 * I_a$$

where I_a is the fraction of surface area in the basin that is impervious.

The volume of stormwater discharging on an annual basis is:

$$V = A * R_v$$

where A is the area.

Suspended solids load is then estimated by multiplying the stormwater runoff volume by the average TSS concentration. The inputs and outputs of this calculation are shown in Table 3-7.

Table 3-7: TSS Loading in stormwater from Basins L and M.

Inputs	Basin M	Basin L
Annual Rainfall (in/yr)	35.02	35.02
Impervious Area Ia	0.55	0.22
Runoff Coefficient 0.05+0.9*Ia	0.545	0.248
Runoff (in/yr)	17.18	7.82
Total Basin Acreage (ac)	29.1	17.2
Avg. Stormwater Discharge (ft ³ /day)	4971	1337
Average TSS(mg/L)	64	176
TSS Load (kg/yr)	3,302	2,432

3.3.6 COI Loading From Stormwater

The load of COIs discharging in stormwater solids was calculated by multiplying the TSS load and the average COI concentration on suspended solids yielding the following values:

Table 3-8: COI Loading on suspended solids in stormwater from Basins L and M.

Subarea	COI	Stormwater Solids Concentration (mg/Kg)	TSS Load (kg/yr)	COI Load (kg/yr)
Basin M	Arsenic (mg/kg)	16.1	3,302	0.05316
	Benzo(a)pyrene (ug/kg)	2.8	3,302	0.00924
	Benzo(b)fluoranthene (ug/kg)	4.5	3,302	0.01486
	Chrysene (ug/kg)	4.4	3,302	0.01453
	Indeno(1,2,3-cd)pyrene (ug/kg)	2.1	3,302	0.00693
Basin L	Arsenic	1.2	2,432	0.00292
	Benzo(a)pyrene	11.2	2,432	0.02724
	Benzo(b)fluoranthene	16.3	2,432	0.03965
	Chrysene	10.5	2,432	0.02554
	Indeno(1,2,3-cd)pyrene	12	2,432	0.02919

3.4 Sedimentation Rate

The deposition rates were estimated in the *Recontamination Analysis Approach* as shown below.

Table 3-9: Summary of sedimentation rates for Terminal 4 based on bathymetric differences between winter 2001/2 and winter 2008/9.

Subarea	Mean Difference (cm)	Sedimentation Rate (cm/yr)	Net Change
Toe of Slip 1	19.8	2.5	Deposition
Wheeler Bay (both areas)	5.2	0.6	Deposition

The surface area of each subarea is shown below.

Table 3-10: River Sediment Subareas.

Subarea	Approximate Area (sq ft)
Wheeler Bay Cap Area	85,000
Wheeler Bay MNR Area	195,000
Toe of Slip 1 MNR Area	55,000

The net mass gain of sediment ($M_{net\ gain,\ RAA}$) in the River Sediment Subarea was calculated from the deposition rate ($R_{deposition}$), area of the subarea (A_{RAA}) and bulk density of sediment (ρ_b):

$$M_{net\ gain,\ RAA} = R_{deposition} * A_{RAA} * \rho_b$$

The estimated sediment density used in the recontamination analysis of 1.53 g/cc was based on the analysis presented in the harborwide RI/FS (LWG, 2009).

The calculated sedimentation rates are shown below.

Table 3-11: Sediment mass deposited (annual average).

Subarea	Total Mass of Sediment Deposited (kg/year)
Wheeler Bay Cap Area	72,500
Wheeler Bay MNR Area	166,300
Toe of Slip 1 MNR Area	195,400

3.5 Sedimentation Mass Balance

The net mass of sediment deposited is equal to the sum of the mass of sediment contributed by the upstream and stormwater sources:

$$M_{net\ gain,\ RAA} = M_{upstream} + M_{stormwater}$$

where

$M_{net\ gain,\ RAA}$ is the net mass of sediment gained annually in the RAA,

$M_{upstream}$ is the mass of sediment contributed annually by upstream sources and

$M_{stormwater}$ is the mass of sediment contributed annually by stormwater sources.

Only a portion of the sediment suspended in discharging stormwater will deposit in the river sediment subarea. Based on physical layout (stormwater outfall locations, subarea configuration, etc.) the percentage of sediment depositing from stormwater is estimated as shown below.

Table 3-12: Estimated deposition rate of stormwater solids in each River Sediment Subarea.

Subarea	Outfall	Total Mass of Suspended Solids Discharging from Outfall (kg/year)	% of Stormwater Solids Depositing in Subarea	Mass of Stormwater Solids depositing in Subarea (kg/yr)
Wheeler Bay Cap Area	L	2,433	50%	1,216
Wheeler Bay MNR Area	L	2,433	25%	608
Toe of Slip 1 MNR Area	M	3,302	25%	825

It is assumed that 75% of the suspended solids from outfall L deposits in Wheeler Bay. Of this two thirds are estimated to deposit in the cap area (closer to the outfall, more quiescent conditions) and one third to deposit in the MNR area. The Toe of Slip 1 MNR Area is narrow and extends a considerable distance from the M outfall. Based on this layout, it was assumed that 25% of the suspended solids deposit in the subarea.

The rate of deposition of sediment from upstream sources was then calculated by subtracting the stormwater contribution from the total sedimentation rate.

Table 3-13: Deposition Rate of upstream sediment in each River Sediment Subarea.

Subarea	Total Mass of Sediment Deposited (kg/year)
Wheeler Bay Cap Area	71,276
Wheeler Bay MNR Area	165,698
Toe of Slip 1 MNR Area	194,619

3.6 COI Concentrations on Upstream Sediment

Sediment is transported in the river, either in suspended form or as bed load. In general terms, the Willamette River is relatively low energy in the Superfund Site study area and tends to accumulate sediment over time (LWG, 2009). There are various sources of sediment and COIs upstream of Terminal 4. The total effect of these has been characterized by the RI in-river sediment sampling.

COI concentrations for the upstream contribution were obtained from the mid-Willamette and Toyota Dolphin sediment traps. The mid-Willamette sediment trap was located toward the center of the river, slightly upstream of Berth 414 and Terminal 4. The Toyota Dolphin trap was located closer to the shoreline, within the Berth 414 sub-area. The proximity of the Toyota Dolphin trap to stormwater outfalls discharging from Basin D presented uncertainty when using this data to represent upstream concentrations. Likewise, uncertainty was present in using the mid-Willamette data, as this trap is located in the center of the river channel and may not represent the type of sediment being deposited in the Removal Action Area. Data from these two locations are similar, however, to address these uncertainties data from both traps were combined by averaging to obtain an estimate of upstream concentrations. The concentrations of COIs measured by this sampling is shown below.

Table 3-14: Upstream COI concentrations measured in the mid-Willamette sediment trap from the January to March 2005 deployment.

COI	Mid-Willamette Sed Trap, Jan-Mar 2005
Arsenic	5.9 mg/kg
Benzo(a)pyrene	67 µg/kg
Benzo(b)fluoranthene	55 ug/kg
Chrysene	66 ug/kg
Indo (1,2,3) pyrene	57 µg/kg

Table 3-15: Upstream COI concentrations measured in the Toyota Dolphin sediment trap from the April and May 2004 deployments.

COI	Toyota Dolphin Sed Trap, April 2004	Toyota Dolphin Sed Trap, May 2004
Arsenic	4 mg/kg	4.5 mg/kg
Benzo(a)pyrene	50 µg/kg	81 µg/kg*
Benzo(b)fluoranthene	53 ug/kg	77 ug/kg
Chrysene	66 ug/kg	79 ug/kg
Indo (1,2,3) pyrene	48 µg/kg*	76 µg/kg*

* Estimated value.

3.7 Initial COI concentration in surface sediment

The initial COI concentration in surface sediment was characterized using the maximum observed detected concentration for each COI by subarea. The surface sediment sampling locations with available data are shown in Figure 3-18. Available surface sediment COI concentrations are shown in Tables 3-17, 3-18, and 3-19. Maximum observed concentrations used in the SEDCAM model are highlighted.



Figure 3-18: Surface Sediment Sampling Locations

Table 3-16: Toe of Slip 1 MNR Area surface sediment concentrations

COI	COI Concentrations			
	Slip1-16	Slip1-18	T4-VC03	WR-PG-09
	11/19/99	11/19/99	3/16/04	5/26/05
Arsenic (mg/kg)	3.4	3.4	3.4	4.22
Benzo(a)pyrene (ug/kg)	97	88	59	57
Benzo(b)fluoranthene (ug/kg)	88	80	53	51
Chrysene (ug/kg)	110	110	64	50
Indeno(1,2,3-cd)pyrene (ug/kg)	93	81	49	58

Table 3-17: Wheeler Bay MNR Area surface sediment concentrations

COI	COI Concentrations												
	BT009	G628	HC-S-43	HC-S-44	SD025	T4-VC17	T4-VC18	T4-VC20	T4-VC21	T4-WB-02	T4-WB-03	T4-WB-04	WR-PG-11
	12/14/05	11/14/07	10/15/98	10/15/98	9/18/97	3/15/04	3/11/04	3/9/04	3/11/04	7/20/06	7/20/06	7/20/06	5/26/05
Arsenic (mg/kg)	4.76	3.01	---	---	5 U	3.6	3.4	2.8	4.3	---	---	---	4.31
Benzo(a)pyrene (ug/kg)	1700	52	1100	670	260	120	250	170	270	190	310	160	150
Benzo(b)fluoranthene (ug/kg)	1200	58	820	670	250	120	220	160	250	160	300	150	120
Chrysene (ug/kg)	1500	51	1100	610	240	130	220	160	240	190	330	190	130
Indeno(1,2,3-cd)pyrene (ug/kg)	1300	40	1700	1400	160	100	220	140	230	81	120	70	140

Note: U - non-detect

Table 3-18: Wheeler Bay Cap Area surface sediment concentrations

COI	COI Concentrations						
	B011	HC-S-41	HC-S-42	SD027	T4-UP10	T4-VC19	T4-WB-01
	7/28/04	10/15/98	10/15/98	9/18/97	3/12/04	3/10/04	7/20/06
Arsenic (mg/kg)	2.51	4	4	5 U	3.3	2.9	---
Benzo(a)pyrene (ug/kg)	0.24 U	20000	14000	650	720	3800	400
Benzo(b)fluoranthene (ug/kg)	0.87	15000	11000	680	680	4000	420
Chrysene (ug/kg)	0.45 U	16000	11000	420	600	3500	390
Indeno(1,2,3-cd)pyrene (ug/kg)	0.26 U	25000	18000	420	650	3100	200

Note: U = non-detect

3.8 Other Parameters

The following subsections discuss the remaining input parameters necessary for the SEDCAM model.

3.8.1.1 Sediment mixed layer thickness

The mixed layer thickness depends on water velocities, ship traffic, activity of benthic organisms and geochemical processes. This value typically ranges between 0 and 25 cm thick (Ecology, 1991). A mixed layer thicknesses of 15 cm was evaluated based on findings from the RI, as well as site-specific water velocity information. Sediment profile images (SPI) taken of sediment cores collected in late fall 2001 show that bioturbation is commonly found in the first 5 cm of sediment, and that surface sediment disturbance appears to be limited to 30 cm harborwide (LWG, 2009). Bathymetric data also show widespread variability in bed elevation up to 30 cm, suggesting that the top 30 cm of sediment is unconsolidated and susceptible to resuspension and erosion (LWG, 2009). This range is similar to that suggested by Ecology (1991) and this was used in the recontamination analysis.

3.8.1.2 Degradation Rate

For this screening level analysis, it was assumed that no degradation would occur. This is a conservative assumption for PAHs.

4.0 RECONTAMINATION ANALYSIS

This section describes the results of the modeling to assess the potential for sediment recontamination due to discharges from stormwater basins L and M at Terminal 4.

The recontamination analysis calculations were conducted for arsenic, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene. The SEDCAM model was run for 30 years on a 1-year time step.

4.1 Model Inputs

Model inputs are summarized in Appendix A. The inputs are from the analyses presented in Section 3 and from other values described in the Recontamination Analysis Approach document.

Tables 4-1, 4-2, and 4-3 show the calculation for the weighted average COI concentrations used in the SEDCAM model. The value for the “Net sedimentation COI Concentration” is important because it is the value at which long-term equilibrium will occur.

**Table 4-1: Weighted average COI concentration calculation for Toe of Slip 1 MNR Area
(Basin M stormwater sedimentation input)**

	Sedimentation Rate (kg/yr)	COPC Concentration (mg/kg)	Weighted COPC load (kg/yr)
Arsenic			
Stormwater sedimentation input rate	825	16.1	0.013
Upstream sedimentation input rate	194,619	5.1	0.988
Net sedimentation	195,445	5.12	1
Benzo(a)pyrene			
Stormwater sedimentation input rate	825	2.8	0.002
Upstream sedimentation input rate	194,619	0.066	0.013
Net sedimentation	195,445	0.08	0.015
Benzo(b)fluoranthene			
Stormwater sedimentation input rate	825	4.5	0.004
Upstream sedimentation input rate	194,619	0.06	0.012
Net sedimentation	195,445	0.08	0.016
Chrysene			
Stormwater sedimentation input rate	825	4.4	0.004
Upstream sedimentation input rate	194,619	0.069	0.013
Net sedimentation	195,445	0.09	0.017
Indeno(b)fluoranthene			
Stormwater sedimentation input rate	825	2.1	0.002
Upstream sedimentation input rate	194,619	0.060	0.012
Net sedimentation	195,445	0.07	0.014

**Table 4-2: Weighted average COI concentration calculation for Wheeler Bay MNR Area
(Basin L stormwater sedimentation input)**

	Sedimentation Rate (kg/yr)	COPC Concentration (mg/kg)	Weighted COPC load (kg/yr)
Arsenic			
Stormwater sedimentation input rate	608	1.2	0.0007
Upstream sedimentation input rate	165,698	5.1	0.84
Net sedimentation	166,306	5.06	0.841
Benzo(a)pyrene			
Stormwater sedimentation input rate	608	11.2	0.007
Upstream sedimentation input rate	165,698	0.066	0.011
Net sedimentation	166,306	0.11	0.018
Benzo(b)fluoranthene			
Stormwater sedimentation input rate	608	16.3	0.01
Upstream sedimentation input rate	165,698	0.06	0.01
Net sedimentation	166,306	0.12	0.02
Chrysene			
Stormwater sedimentation input rate	608	10.5	0.006
Upstream sedimentation input rate	165,698	0.069	0.011
Net sedimentation	166,306	0.11	0.017
Indeno(b)fluoranthene			
Stormwater sedimentation input rate	608	12	0.007
Upstream sedimentation input rate	165,698	0.060	0.01
Net sedimentation	166,306	0.10	0.017

**Table 4-3: Weighted average COI concentration calculation for Wheeler Bay Cap Area
(Basin L stormwater sedimentation input)**

	Sedimentation Rate (kg/yr)	COPC Concentration (mg/kg)	Weighted COPC load (kg/yr)
Arsenic			
Stormwater sedimentation input rate	1,216	1.2	0.002
Upstream sedimentation input rate	71,276	5.1	0.362
Net sedimentation	72,492	5.01	0.364
Benzo(a)pyrene			
Stormwater sedimentation input rate	1,216	11.2	0.014
Upstream sedimentation input rate	71,276	0.066	0.005
Net sedimentation	72,492	0.25	0.019
Benzo(b)fluoranthene			
Stormwater sedimentation input rate	1,216	16.3	0.02
Upstream sedimentation input rate	71,276	0.06	0.004
Net sedimentation	72,492	0.33	0.024
Chrysene			
Stormwater sedimentation input rate	1,216	10.5	0.013
Upstream sedimentation input rate	71,276	0.069	0.005
Net sedimentation	72,492	0.24	0.018
Indeno(b)fluoranthene			
Stormwater sedimentation input rate	1,216	12	0.015
Upstream sedimentation input rate	71,276	0.060	0.004
Net sedimentation	72,492	0.26	0.019

4.2 SEDCAM modeling results

The SEDCAM model was conducted for a 30 year time period on a 1-year time step. Outputs from each model run are provided in Appendix B.

The following main observations from the input parameters, calculated loads and output graphs are as follows:

Arsenic

- Arsenic concentrations on suspended solids in stormwater discharging from Basin L are below upgradient background levels in the river (upgradient background level in the river is estimated at 4.8 mg/Kg based on sediment trap data; see Section 3.6). Basin L stormwater is therefore not a potential recontamination source for arsenic.
- Arsenic concentrations on suspended solids in stormwater discharging from Basin M are slightly elevated relative to background levels in the river. However, the predicted effect on surface sediments in the Toe of Slip 1 MNR area is an increase of less than 1 mg/Kg. This information, combined with

the poor correlation between total arsenic and TSS concentrations in Basin M stormwater, indicate that Basin M stormwater is not a potential recontamination source for arsenic.

PAHs

- For all PAHs, it is predicted that current concentrations in surface sediment will reduce with time. Therefore, stormwater from Basins M and L are not a potential recontamination source for current conditions, or areas of sediment that will undergo MNR as part of the final remedy.
- For the portion of Wheeler Bay identified in the removal action as warranting a cap, initial concentrations are estimated to be zero in this screening-level analysis, assuming suitable cap materials. Concentrations increase to equilibrium levels as shown in the table below. The Portland Harbor risk assessment uses toxicity equivalency factors for individual PAHs and sums them to calculate a toxic equivalent value (TEQ). The TEQ for the four PAHs evaluated is 0.316 mg/Kg, as shown in the table below. This is below the preliminary remediation goal (PRG) of 0.423 mg/Kg. This comparison is highly conservative because the PRG applies to half-mile stretches of the river and the Wheeler Bay Cap subarea is considerably smaller.

Table 4-4: Predicted PAH equilibrium concentrations for Wheeler Bay Cap Area

COI	Equilibrium Concentration (mg/Kg)	TEF	Bap Equivalent Concentration (ug/kg)
Benzo(a)pyrene (ug/kg)	0.25	1.0	250
Benzo(b)fluoranthene (ug/kg)	0.33	0.1	33
Chrysene (ug/kg)	0.24	0.03	7.2
Indeno(1,2,3-cd)pyrene (ug/kg)	0.26	0.1	26
	Sum		316

5.0 SENSITIVITY ANALYSIS

The purpose of a sensitivity analysis is to identify the parameters/inputs to which the model predictions are most sensitive (i.e., relatively small to modest changes in the input value [within a range of values that is supported by the available site data or literature] illicit a modest to large response in the model). A detailed description of data sources and uncertainties was provided in the *Sediment Recontamination Approach* document.

The primary inputs are as follows:

- Stormwater sediment load to River Sediment Subarea
- Sedimentation rate in River Sediment Subarea
- Areal extent of River Sediment Subarea
- Sediment mixing layer
- COI Degradation rate
- Stormwater COI concentrations
- Upstream COI concentrations

Review of the model equation provides a simple approach to understanding how outputs might change as input parameters vary. As an example, the following figures show predicted Benzo(a)pyrene concentrations in the Wheeler Bay MNR area with varying input parameters.

Table 5-1 shows the weighted average concentration and inputs for the SEDCAM model when doubling or halving the stormwater COI concentration.

Table 5-1: Weighted average COI concentration by varying the stormwater COI concentration (Wheeler Bay MNR Area)

	Sedimentation Rate (kg/yr)	COPC Concentration (mg/kg)	Weighted COPC load (kg/yr)
Benzo(a)pyrene – Twice Stormwater COI Concentration			
Stormwater sedimentation input rate	608	22.4	0.014
Upstream sedimentation input rate	165,698	0.066	0.011
Net sedimentation	166,306	0.15	0.025
Benzo(a)pyrene – Original Stormwater COI Concentration			
Stormwater sedimentation input rate	608	11.2	0.007
Upstream sedimentation input rate	165,698	0.066	0.011
Net sedimentation	166,306	0.11	0.018
Benzo(a)pyrene – Half Stormwater COI Concentration			
Stormwater sedimentation input rate	608	5.6	0.003
Upstream sedimentation input rate	165,698	0.066	0.011
Net sedimentation	166,306	0.09	0.014

Figure 5-1 shows the predicted effect of halving and doubling the concentration on suspended sediments in stormwater. As shown, varying the stormwater concentration has minimal effect. This is because upstream stormwater sediment dominates the sediment balance for deposition.

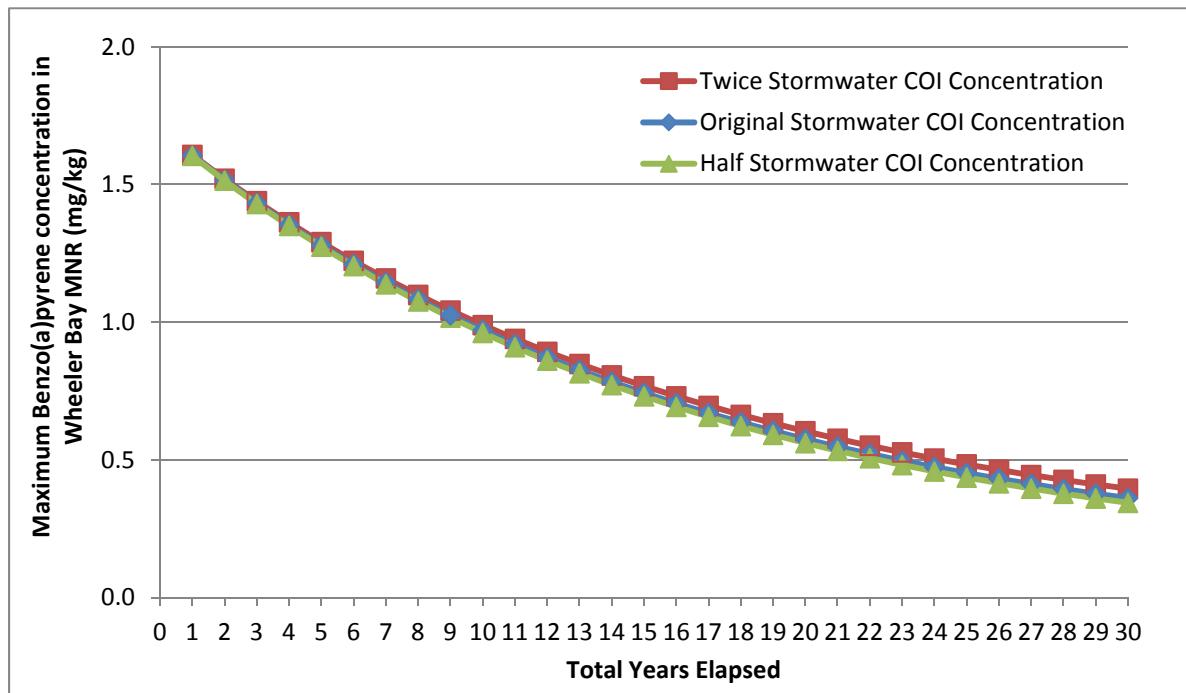


Figure 5-1: Effect of varying stormwater COI concentration on predicted future surface sediment concentrations

Table 5-2 shows the weighted average calculation and inputs for the SEDCAM model when doubling the concentration and halving the concentration of suspended sediments in stormwater.

Table 5-2: Weighted average COI concentration by varying the TSS Load (Wheeler Bay MNR Area)

	Sedimentation Rate (kg/yr)	COPC Concentration (mg/kg)	Weighted COPC load (kg/yr)
Benzo(a)pyrene – Twice Stormwater TSS Load			
Stormwater sedimentation input rate	1,216	11.2	0.014
Upstream sedimentation input rate	165,090	0.066	0.011
Net sedimentation	166,306	0.15	0.025
Benzo(a)pyrene – Original Stormwater Load			
Stormwater sedimentation input rate	608	11.2	0.007
Upstream sedimentation input rate	165,698	0.066	0.011
Net sedimentation	166,306	0.11	0.018
Benzo(a)pyrene – Half Stormwater TSS Load			
Stormwater sedimentation input rate	304	11.2	0.003
Upstream sedimentation input rate	166,002	0.066	0.011
Net sedimentation	166,306	0.09	0.014

Figure 5-2 shows the predicted effect of halving and doubling the stormwater TSS load. This figure is identical to Figure 5-1. The key factor is COI load in stormwater, which is concentration on suspended sediments multiplied by the load of suspended sediments. It is noted that this also applies to the assumption on the percentage of the stormwater sediment that settles in any given river sediment subarea. Doubling or halving that value has the same effect on the results.

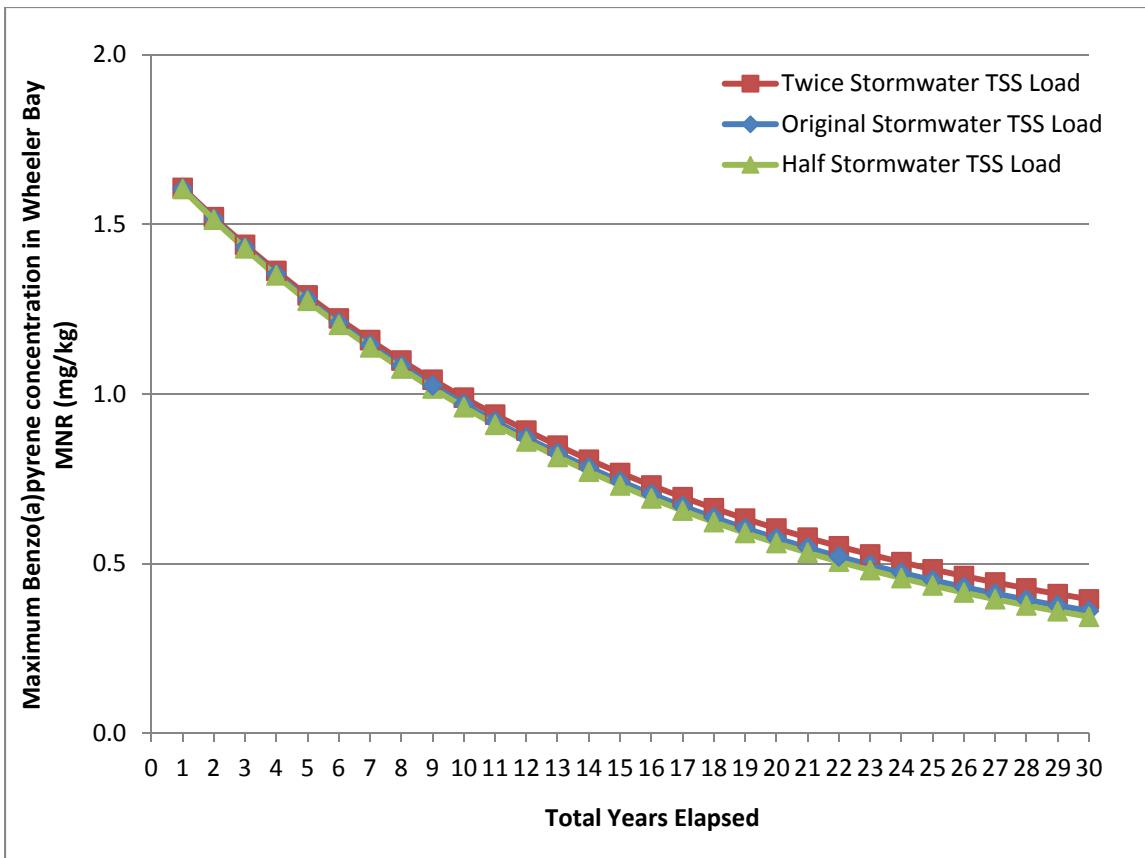


Figure 5-2: Effect of varying stormwater TSS load on predicted future surface sediment concentrations

Figure 5-3 shows the predicted effect of halving and doubling the sediment mixing layer. This input does not affect the final equilibrium COI concentration in surface sediment, but thicker mixing layers slow the rate of change.

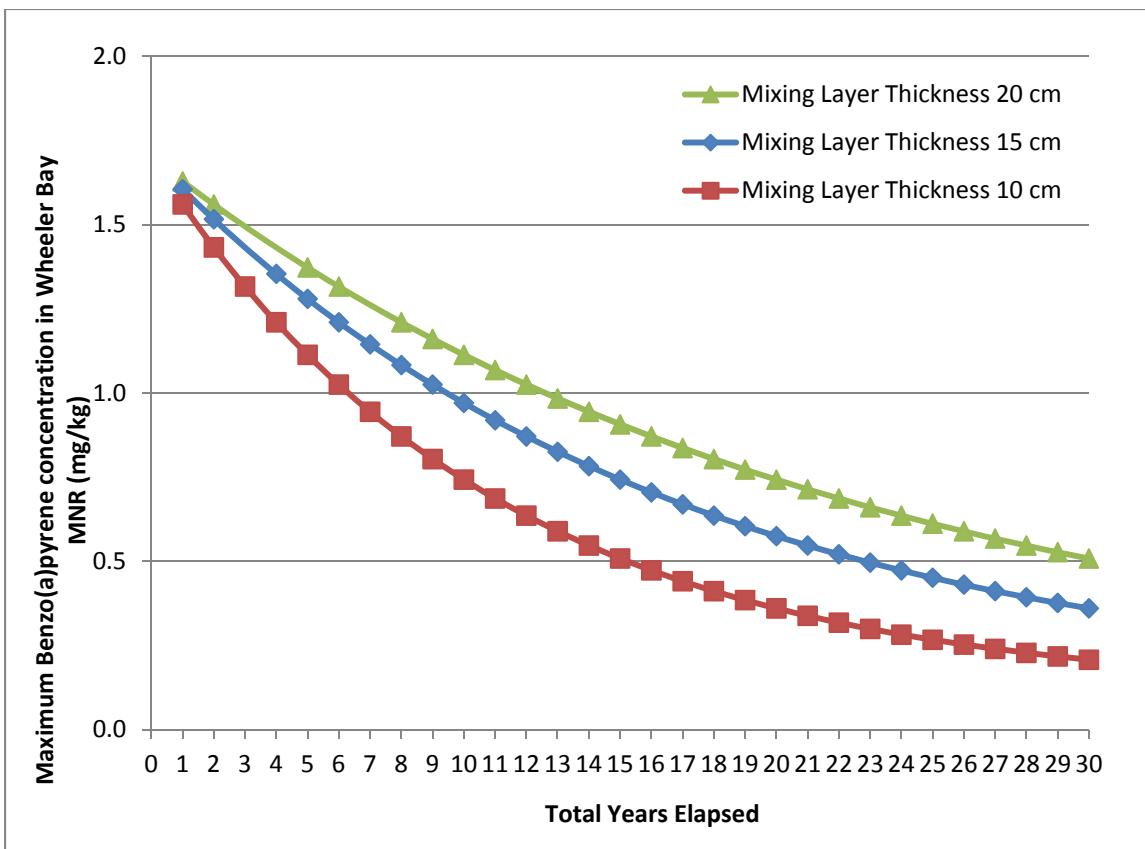


Figure 5-3: Effect of varying sediment mixing layer on predicted surface sediment concentrations

Table 5-3 shows the weighted average calculation and inputs for the SEDCAM model when doubling (1.2 cm/year) and halving (0.3 cm/year) the sedimentation rate.

	Sedimentation Rate (kg/yr)	COPC Concentration (mg/kg)	Weighted COPC load (kg/yr)
Benzo(a)pyrene – Twice Sedimentation Rate			
Stormwater sedimentation input rate	608	11.2	0.007
Upstream sedimentation input rate	332,004	0.066	0.022
Net sedimentation	332,612	0.09	0.029
Benzo(a)pyrene – Original Sedimentation Rate			
Stormwater sedimentation input rate	608	11.2	0.007
Upstream sedimentation input rate	165,698	0.066	0.011
Net sedimentation	166,306	0.11	0.018
Benzo(a)pyrene – Half Sedimentation Rate			
Stormwater sedimentation input rate	608	11.2	0.007
Upstream sedimentation input rate	82,545	0.066	0.006
Net sedimentation	83,153	0.015	0.013

Table 5-3: Weighted average COI concentration by varying the sedimentation rate (Wheeler Bay MNR Area)

Figure 5-4 shows the predicted effect of halving and doubling the overall sedimentation rate. This parameter has a greater effect on predicted future COI concentrations. Lowering the overall sedimentation rate while fixing the stormwater sediment input, increases the effect of stormwater input relative to upstream and results in higher predicted future COI concentration in surface sediments. However, as shown in this example, even at half the overall sedimentation rate, concentrations decline over time. If the sedimentation rate is set too low, then the area is less depositional, making it less likely that stormwater sediments would settle there. Therefore, from a physical perspective lowering sedimentation rates should also be accompanied by a lowering of the stormwater COI mass flux, somewhat reducing the effect shown. As such, this is conservative assumption for purposes of this sensitivity analysis.

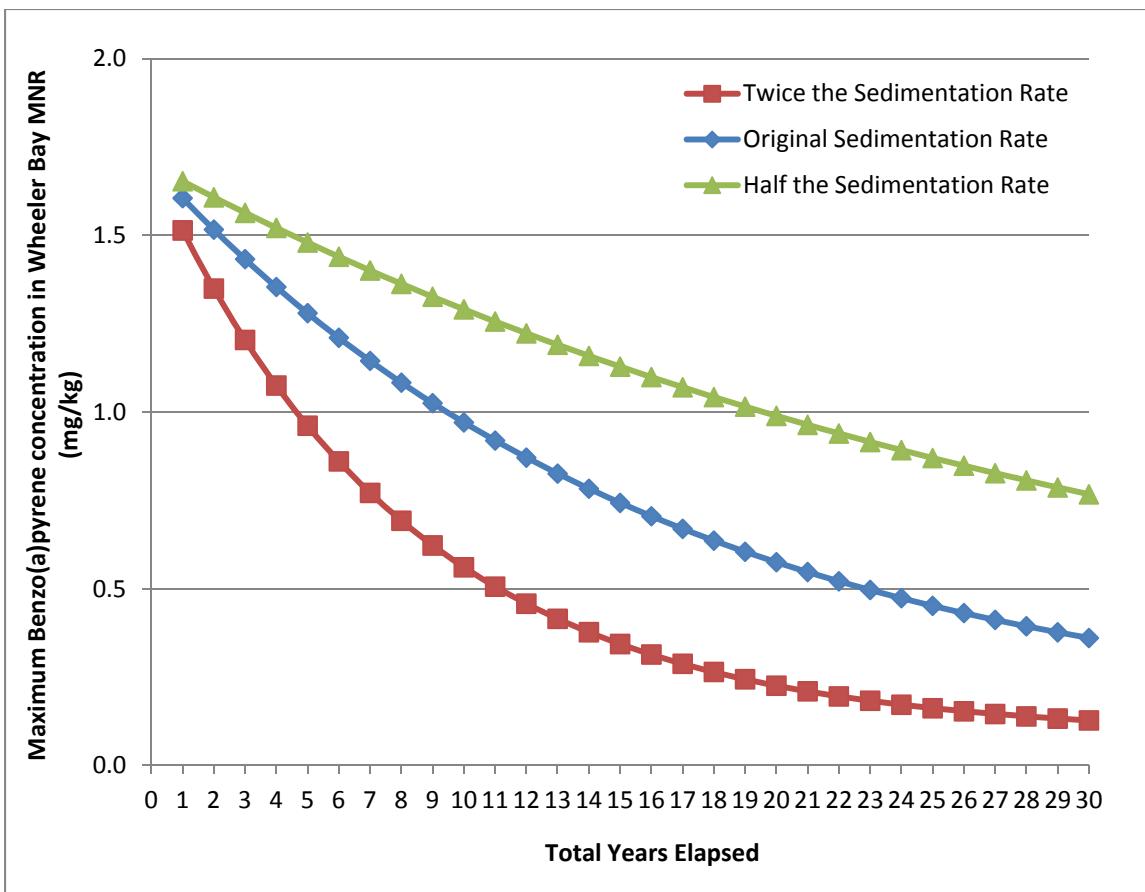


Figure 5-4: Effect of varying sedimentation rate on predicted surface sediment concentrations

6.0 CONCLUSIONS

This report provides a screening level recontamination analysis for a portion of the Port's Terminal 4 on the Willamette River. It assesses the potential for recontamination of river sediments due to arsenic and PAHs in stormwater discharges from basins M and L.

The primary conclusions of this screening level recontamination analysis are:

- There are adequate stormwater data to support the recontamination analysis. While there is natural variation in stormwater chemistry, normalizing the COI data to suspended solids concentrations provides sufficient information on average stormwater conditions needed for the analysis.
- There is no potential for recontamination of sediments by arsenic. The stormwater concentrations are low and are predicted to have minimal potential effect of surface sediments.
- The analysis indicates that all PAH concentrations in surface sediments will decrease over time. Therefore, recontamination potential is not indicated relative to current conditions.
- In the area of Wheeler Bay where capping is assumed as the remedy, PAH concentrations increase initially (cap materials are assumed to have zero concentrations) and equilibrate at levels over the long term at levels that are below PRGs being evaluated under the Portland Harbor RI/FS process. Therefore recontamination of the cap is not predicted.
- The sensitivity analysis indicates that changes in COI concentrations and loading (i.e. considering TSS load) from stormwater do not significantly affect the predicted concentrations in river sediments in the future. This is because deposition of river sediment from upstream dominates loading to the areas of interest.

The screening level recontamination analysis was performed to provide another line of evidence to the results and information presented in the Storm Water Source Control Completion Report (Ash Creek, 2011).

7.0 REFERENCES

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APPENDIX A

Summary of Model Input Values

Appendix A: Model Inputs

Table 4-1: Summary of model input values for Toe of Slip 1 MNR Area Calculation

General Model Input Values – Toe of Slip 1 MNR Area		
Area of River Sediment Subarea	55,000	ft ²
Total load of sediment to subarea ¹	195,445	kg/yr
Mixing layer thickness ²	15	cm
Degradation rate	0.00E+00	yr ⁻¹
Time step	1	yr

COI Model Input Concentrations – Toe of Slip 1 MNR Area		
COI	Weighted Average Input Concentration³	Initial Concentration⁴
Arsenic	5.12 mg/kg	4.2 mg/kg
Benzo(a)pyrene	0.08 mg/kg	0.1 mg/kg
Benzo(b)fluoranthene	0.08 mg/kg	0.1 mg/kg
Chrysene	0.09 mg/kg	0.1 mg/kg
Indeno(1,2,3-cd)pyrene	0.07 mg/kg	0.1 mg/kg

¹Based on an annual net sedimentation rate of 2.5 cm/yr.

² Assumed value.

³ Weighted average of stormwater and upstream source inputs based on relative magnitude of sediment

⁴ Maximum concentration of COI in Toe of Slip 1 MNR Area.

Table 4-2: Summary of model input values for Wheeler Bay MNR Area Calculation

General Model Input Values – Wheeler Bay MNR Area		
Area of River Sediment Subarea	195,000	ft ²
Total load of sediment to subarea ¹	166,306	kg/yr
Mixing layer thickness ²	15	cm
Degradation rate	0.00E+00	yr ⁻¹
Time step	1	yr

COI Model Input Concentrations – Wheeler Bay MNR Area		
COI	Weighted Average Input Concentration³	Initial Concentration⁴
Arsenic	5.06 mg/kg	4.8 mg/kg
Benzo(a)pyrene	0.11 mg/kg	1.7 mg/kg
Benzo(b)fluoranthene	0.12 mg/kg	1.2 mg/kg
Chrysene	0.11 mg/kg	1.5 mg/kg
Indeno(1,2,3-cd)pyrene	0.10 mg/kg	1.7 mg/kg

¹Based on an annual net sedimentation rate of 0.6 cm/yr.

² Assumed value.

³ Weighted average of stormwater and upstream source inputs based on relative magnitude of sediment

⁴ Maximum concentration of COI in Wheeler Bay MNR Area.

Appendix A: Model Inputs

Table 4-3: Summary of model input values for Wheeler Bay Cap Area Current Conditions Calculation

General Model Input Values – Wheeler Bay Cap Area		
Area of River Sediment Subarea	85,000	ft ²
Total load of sediment to subarea ¹	72,492	kg/yr
Mixing layer thickness ²	15	cm
Degradation rate	0.00E+00	yr ⁻¹
Time step	1	yr

COI Model Input Concentrations – Wheeler Bay Cap Area		
COI	Weighted Average Input Concentration³	Initial Concentration⁴
Arsenic	5.01 mg/kg	4 mg/kg
Benzo(a)pyrene	0.25 mg/kg	20 mg/kg
Benzo(b)fluoranthene	0 mg/kg	15 mg/kg
Chrysene	0.24 mg/kg	16 mg/kg
Indeno(1,2,3-cd)pyrene	0.26 mg/kg	25 mg/kg

¹Based on an annual net sedimentation rate of 0.6 cm/yr.

² Assumed value.

³Weighted average of stormwater and upstream source inputs based on relative magnitude of sediment

⁴Maximum concentration of COI in Wheeler Bay MNR Area.

Table 4-4: Summary of model input values for Wheeler Bay Cap Area with Cap Calculation

General Model Input Values – Wheeler Bay Cap Area		
Area of River Sediment Subarea	85,000	ft ²
Total load of sediment to subarea ¹	72,492	kg/yr
Mixing layer thickness ²	15	cm
Degradation rate	0.00E+00	yr ⁻¹
Time step	1	yr

COI Model Input Concentrations – Wheeler Bay Cap Area		
COI	Weighted Average Input Concentration³	Initial Concentration⁴
Arsenic	5.01 mg/kg	0 mg/kg
Benzo(a)pyrene	0.25 mg/kg	0 mg/kg
Benzo(b)fluoranthene	0 mg/kg	0 mg/kg
Chrysene	0.24 mg/kg	0 mg/kg
Indeno(1,2,3-cd)pyrene	0.26 mg/kg	0 mg/kg

¹Based on an annual net sedimentation rate of 0.6 cm/yr.

² Assumed value.

³Weighted average of stormwater and upstream source inputs based on relative magnitude of sediment

⁴Maximum concentration of COI in Wheeler Bay MNR Area.

APPENDIX B

Model Outputs

Appendix B: SEDCAM Model Output
Toe of Slip 1 MNR Area - Arsenic

Estimate recontamination in Slip 1

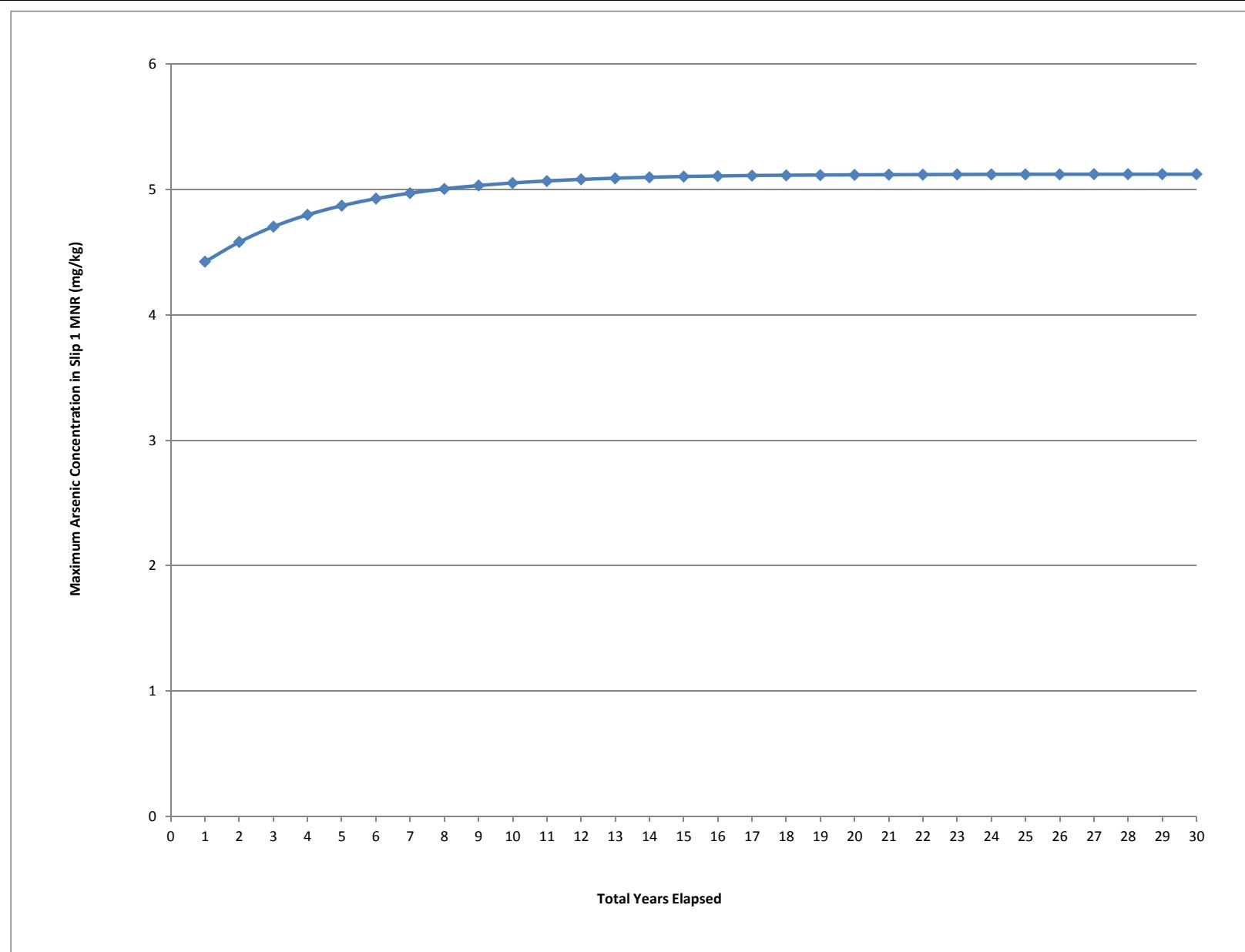
MNR Area **Arsenic** FROM MAX

Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Maximum concentration of Arsenic at any point in Slip 1 MNR, $C_c(t)$	4.42	4.58	4.70	4.80	4.87	4.93	4.97	5.00	5.03	5.05	5.07	5.08	5.09	5.10	5.10	5.11	5.11	5.11	5.12	5.12	5.12	5.12	5.12	5.12	5.12	5.12	5.12	5.12 mg/kg		
Mixing Layer thickness, ML	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00 cm			
Mass/Area, R_s	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83 g/cm ²			
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹			
Initial Concentration, C_o	4.2	4.4	4.6	4.7	4.8	4.9	4.9	5.0	5.0	5.0	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1 ug/kg			
Input Concentration, C_p	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1 ug/kg			
Time step elapsed, t	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00 yr				
Ts = ML/R _s	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92				
1+kTs	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00				
e ^{-(1+kTs)t/Ts}	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77				

Total load of COPC 1.001 kg/yr
 Total load of sediment 195,445 kg/yr
 Concentration of input 5.12 mg/kg

R_s = mass/area 3.825 g/cm²
 Total Area 55,000 ft²
 Total Mass Load 195,445 kg/yr

Assumes mixing occur in 15cm (~half a foot).



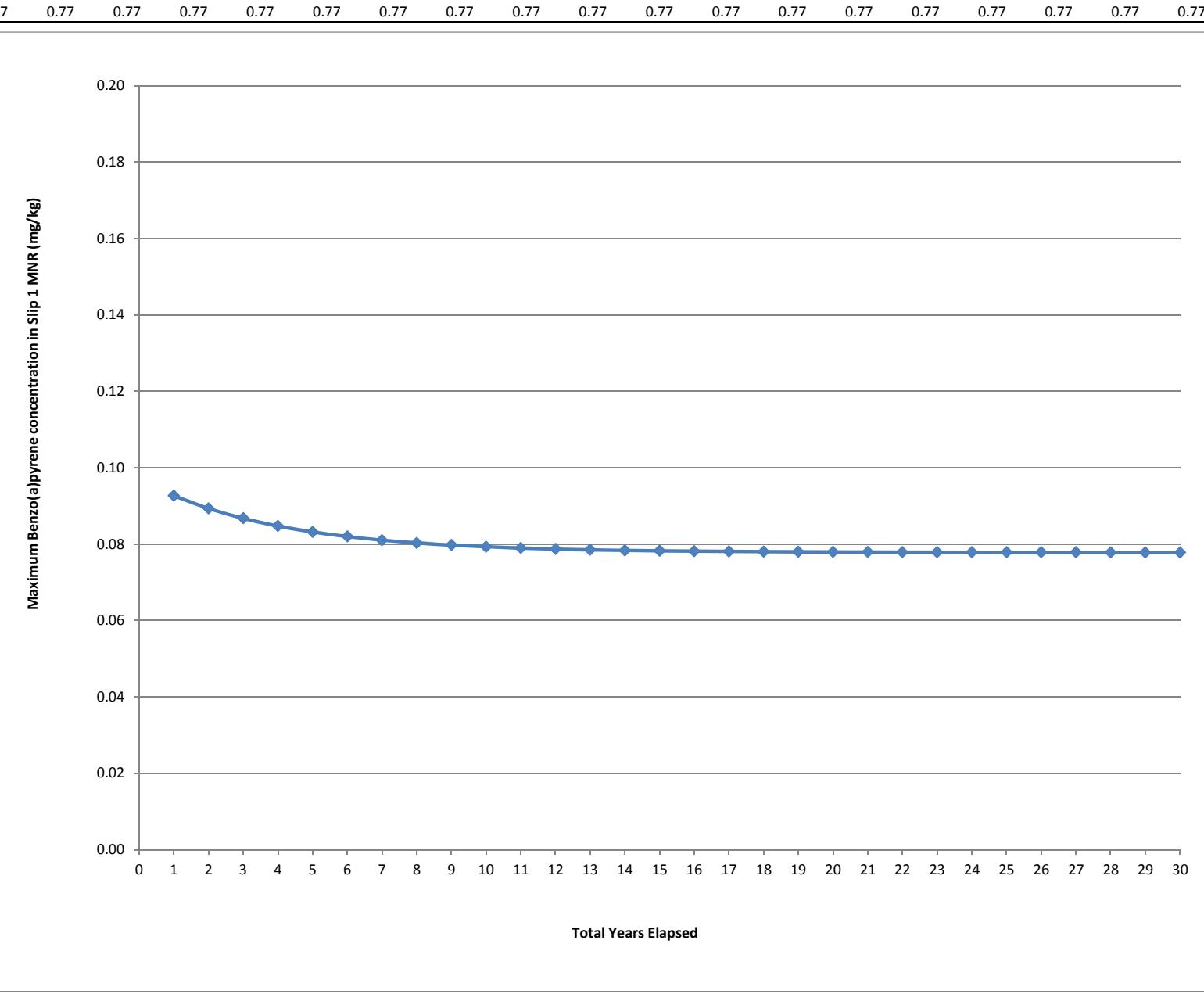
Appendix B: SEDCAM Model Output
Toe of Slip 1 MNR Area - Benzo(a)pyrene

Estimate recontamination in Slip

1 MNR Area Benzo(a)pyrene FROM MAX

Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Maximum concentration of Benzo(a)pyrene at any point in Slip 1 MNR, $C_c(t)$																														
Mixing Layer thickness, ML	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00 cm	
Mass/Area, R_s	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83 g/cm ²	
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹	
Initial Concentration, C_0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1 ug/kg	
Input Concentration, C_p	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1 ug/kg	
Time step elapsed, t	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00 yr		
Ts = ML/R _s	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92		
1+kTs	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
e ^{(-1+kTs)t/Ts}	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77		
Total load of COPC	0.015 kg/yr																													
Total load of sediment	195,445 kg/yr																													
Concentration of input	0.08 mg/kg																													
R_s = mass/area	3.825 g/cm ²																													
Total Area	55,000 ft ²																													
Total Mass Load	195,445 kg/yr																													

Assumes mixing occur in 15cm (~half a foot).



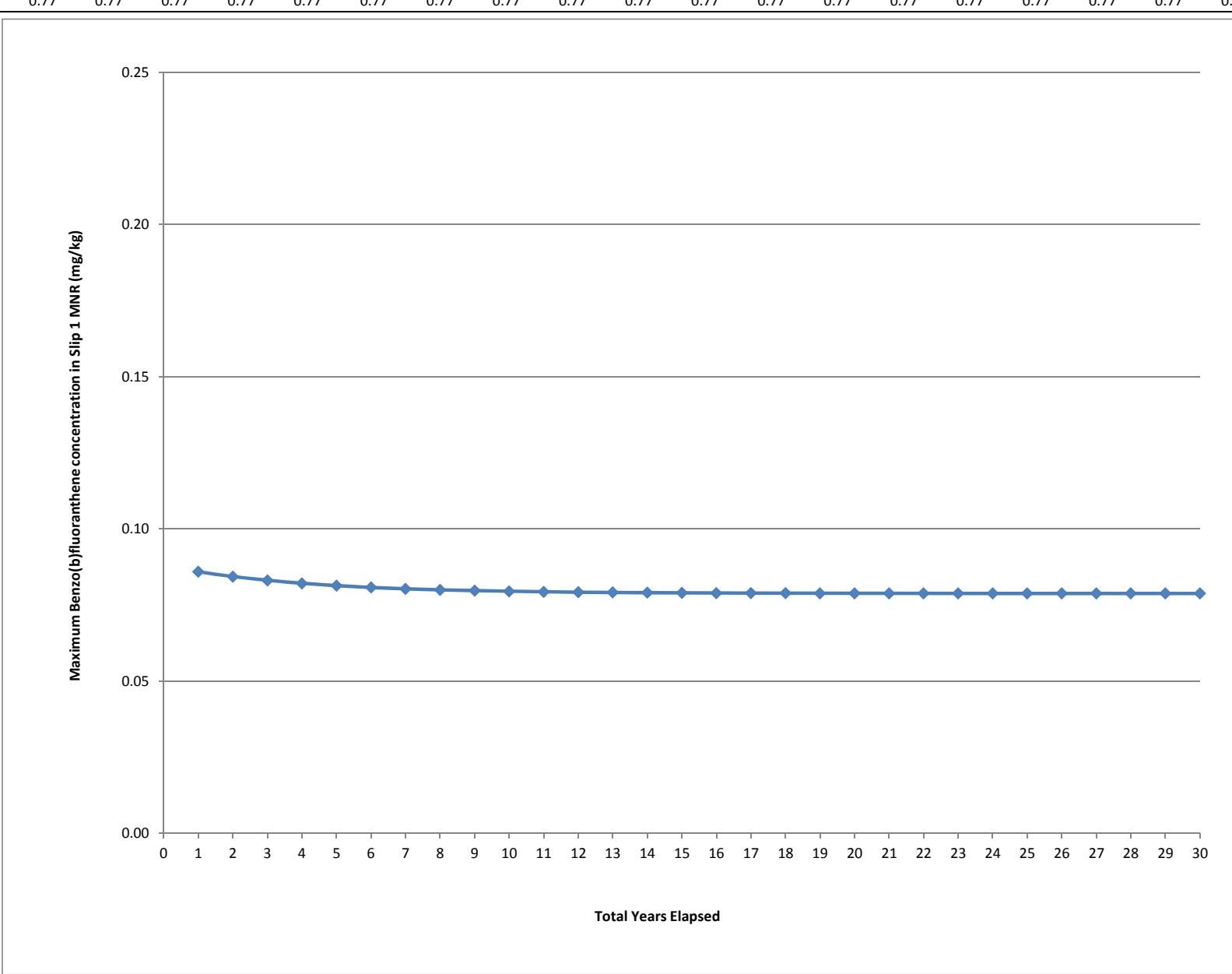
Appendix B: SEDCAM Model Output
Toe of Slip 1 MNR Area - Benzo(b)fluoranthene

Estimate recontamination in Slip 1 MNR

Area Benzo(b)fluoranthene FROM MAX

Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Maximum concentration of Benzo(a)fluoranthene at any point in Slip	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08 mg/kg		
Mixing Layer thickness, ML	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00 cm			
Mass/Area, R_s	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83 g/cm ²			
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹			
Initial Concentration, C_0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1 ug/kg			
Input Concentration, C_p	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1 ug/kg			
Time step elapsed, t	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00 yr				
Ts = ML/R _s	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92			
1+kTs	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
e^{-(1+kTs)t/Ts}	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77			
Total load of COPC	0.015 kg/yr																													
Total load of sediment	195,445 kg/yr																													
Concentration of input	0.08 mg/kg																													
R_s = mass/area	3.825 g/cm ²																													
Total Area	55,000 ft ²																													
Total Mass Load	195,445 kg/yr																													

Assumes mixing occur in 15cm (~half a foot).

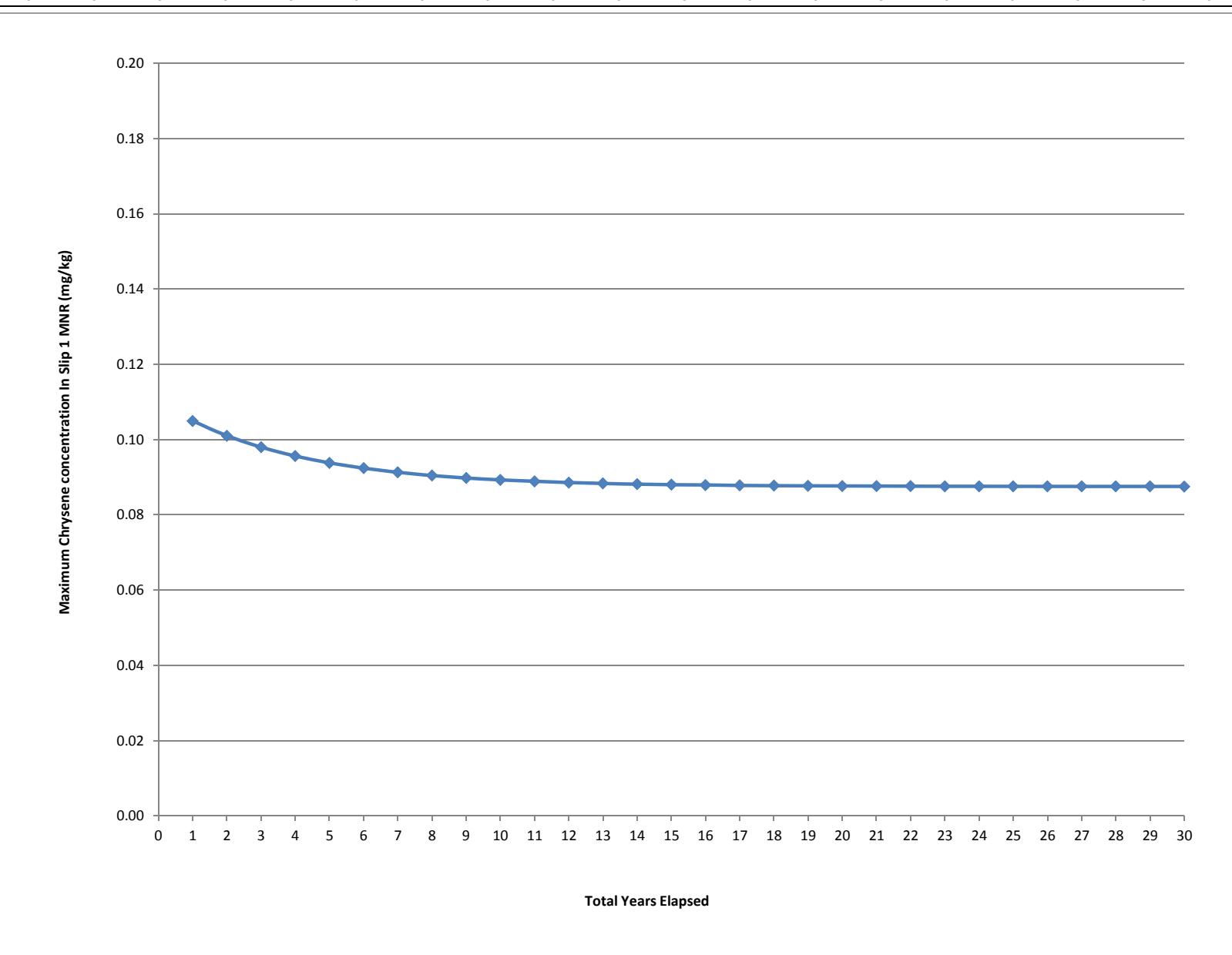


Appendix B: SEDCAM Model Output
Toe of Slip 1 MNR Area - Chrysene

Estimate recontamination in Slip 1

MNR Area	Chrysene		FROM MAX																											
Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Maximum concentration of Chrysene at any point in Slip 1 MNR, $C_c(t)$	0.10	0.10	0.10	0.10	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09 mg/kg	
Mixing Layer thickness, ML	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00 cm		
Mass/Area, R_s	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83 g/cm ²		
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹		
Initial Concentration, C_o	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1 ug/kg		
Input Concentration, C_p	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1 ug/kg		
Time step elapsed, t	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00 yr			
Ts = ML/R _s	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92			
1+kTs	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
e ^{-(1+kTs)t/Ts}	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77			
Total load of COPC	0.017 kg/yr																													
Total load of sediment	195,445 kg/yr																													
Concentration of input	0.09 mg/kg																													
R _s = mass/area	3.825 g/cm ²																													
Total Area	55,000 ft ²																													
Total Mass Load	195,445 kg/yr																													

Assumes mixing occur in 15cm (~half a foot).

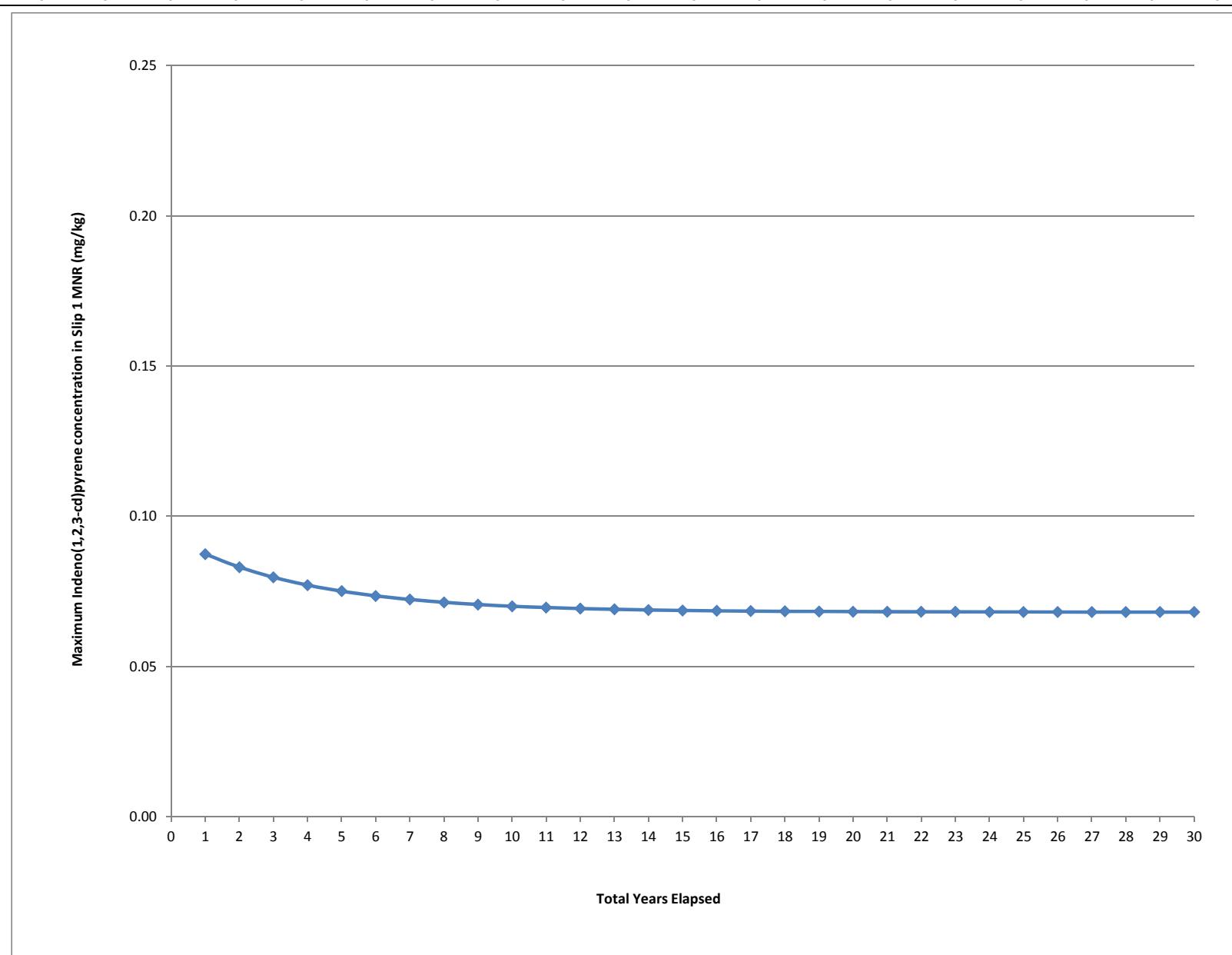


Appendix B: SEDCAM Model Output
Toe of Slip 1 MNR Area - Indeno(1,2,3-cd)pyrene

Estimate recontamination in Slip 1 MNR Area Indeno(1,2,3-cd)pyrene **FROM MAX**

Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Maximum concentration of Indeno(1,2,3-cd)pyrene at any point in Slip 1 MNR, $C_c(t)$	0.09	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07 mg/kg	
Mixing Layer thickness, ML	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00 cm		
Mass/Area, R_s	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83 g/cm ²			
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹		
Initial Concentration, C_0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1 ug/kg		
Input Concentration, C_p	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1 ug/kg		
Time step elapsed, t	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00 yr			
$T_s = ML/R_s$	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92			
$1+kT_s$	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
$e^{-(1+kT_s)t/T_s}$	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77			
Total load of COPC	0.013 kg/yr																													
Total load of sediment	195,445 kg/yr																													
Concentration of input	0.07 mg/kg																													
$R_s = \text{mass/area}$	3.825 g/cm ²																													
Total Area	55,000 ft ²																													
Total Mass Load	195,445 kg/yr																													

Assumes mixing occur in 15cm (~half a foot).



Appendix B: SEDCAM Model Output
Wheeler Bay MNR Area - Arsenic

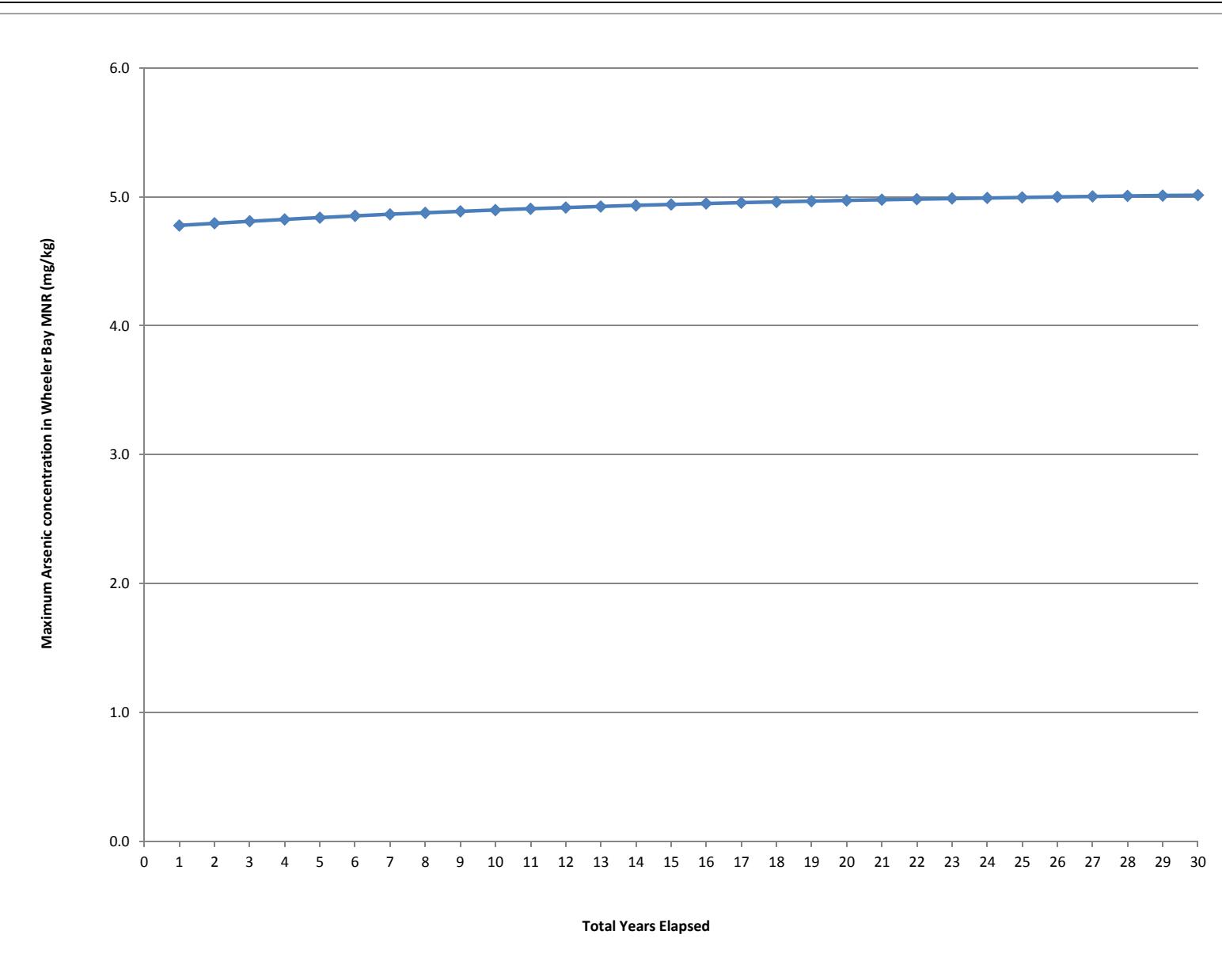
Estimate recontamination in

Wheeler Bay MNR Area

Arsenic FROM MAX

Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Maximum concentration of Arsenic at any point in Slip 1 MNR, $C_c(t)$	4.78	4.79	4.81	4.83	4.84	4.85	4.86	4.88	4.89	4.90	4.91	4.92	4.93	4.93	4.94	4.95	4.95	4.96	4.97	4.97	4.98	4.98	4.99	4.99	5.00	5.00	5.00	5.01	5.01 mg/kg	
Mixing Layer thickness, ML	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00 cm		
Mass/Area, R_s	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92 g/cm ²			
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹		
Initial Concentration, C_o	4.8	4.8	4.8	4.8	4.8	4.8	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9 ug/kg			
Input Concentration, C_p	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1 ug/kg			
Time step elapsed, t	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00 yr				
Ts = ML/R _s	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34			
1+kTs	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
e ^{(-1+kTs)t/Ts}	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94			
Total load of COPC	0.842 kg/yr																													
Total load of sediment	166,306 kg/yr																													
Concentration of input	5.06 mg/kg																													
R_s = mass/area	0.918 g/cm ²																													
Total Area	195,000 ft ²																													
Total Mass Load	166,306 kg/yr																													

Assumes mixing occur in 15cm (~half a foot).

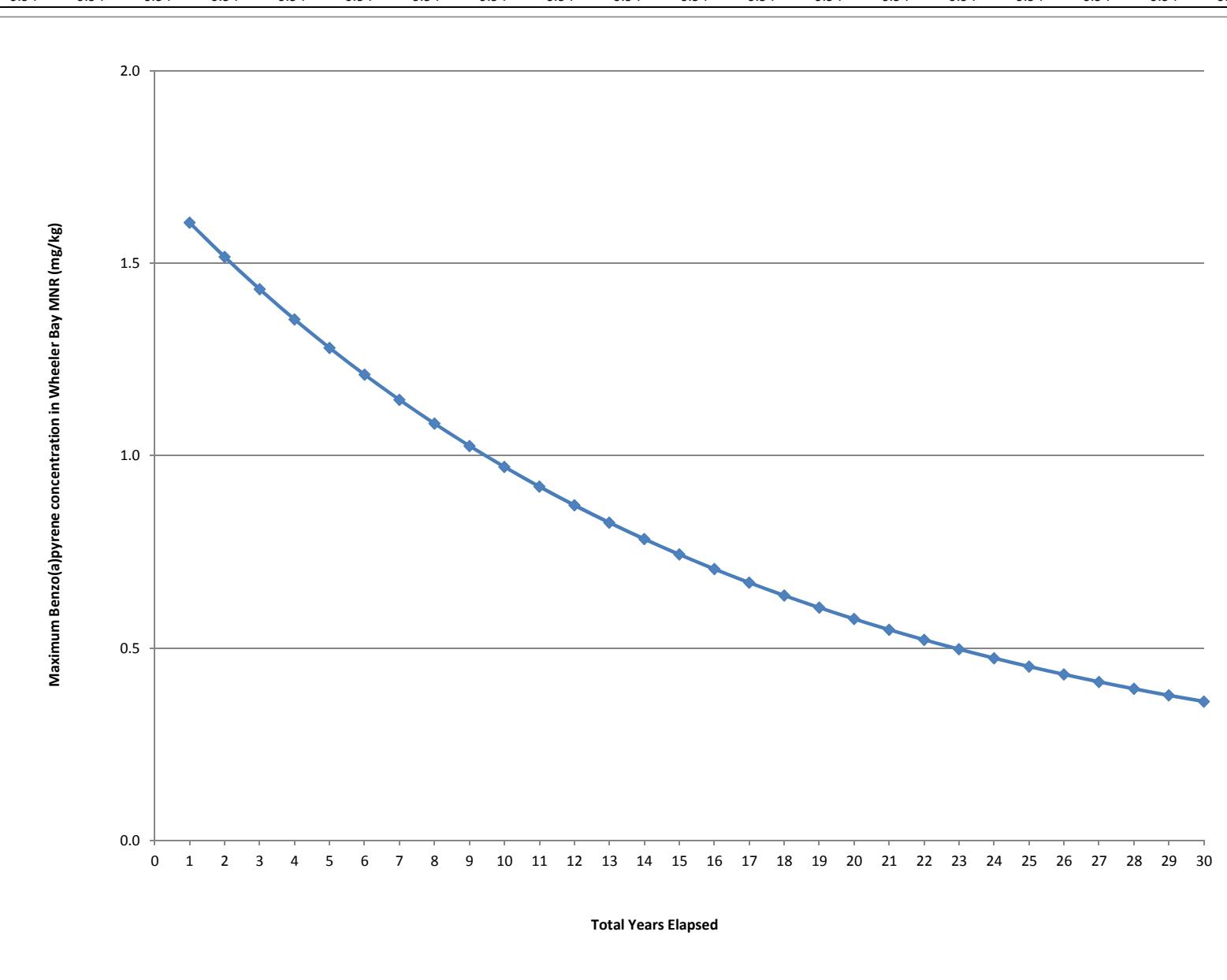


Appendix B: SEDCAM Model Output
Wheeler Bay MNR Area - Benzo(a)pyrene

Estimate recontamination in Wheeler Bay MNR

Area	Benzo(a)pyrene		FROM MAX																												
	Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Maximum concentration of Benzo(a)pyrene at any point in Wheeler Bay MNR, $C_c(t)$	1.61	1.52	1.43	1.35	1.28	1.21	1.14	1.08	1.03	0.97	0.92	0.87	0.83	0.78	0.74	0.71	0.67	0.64	0.60	0.58	0.55	0.52	0.50	0.47	0.45	0.43	0.41	0.39	0.38	0.36 mg/kg	
Mixing Layer thickness, ML	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00 cm		
Mass/Area, R_s	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92 g/cm ²		
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹		
Initial Concentration, C_0	1.7	1.6	1.5	1.4	1.4	1.3	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4 ug/kg			
Input Concentration, C_p	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1 ug/kg			
Time step elapsed, t	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00 yr			
Ts = ML/R _s	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34			
1+kTs	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
e ^{-(1+kTs)t/Ts}	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94		
Total load of COPC	0.018 kg/yr																														
Total load of sediment	166,306 kg/yr																														
Concentration of input	0.11 mg/kg																														
R _s = mass/area	0.918 g/cm ²																														
Total Area	195,000 ft ²																														
Total Mass Load	166,306 kg/yr																														

Assumes mixing occur in 15cm (~half a foot).



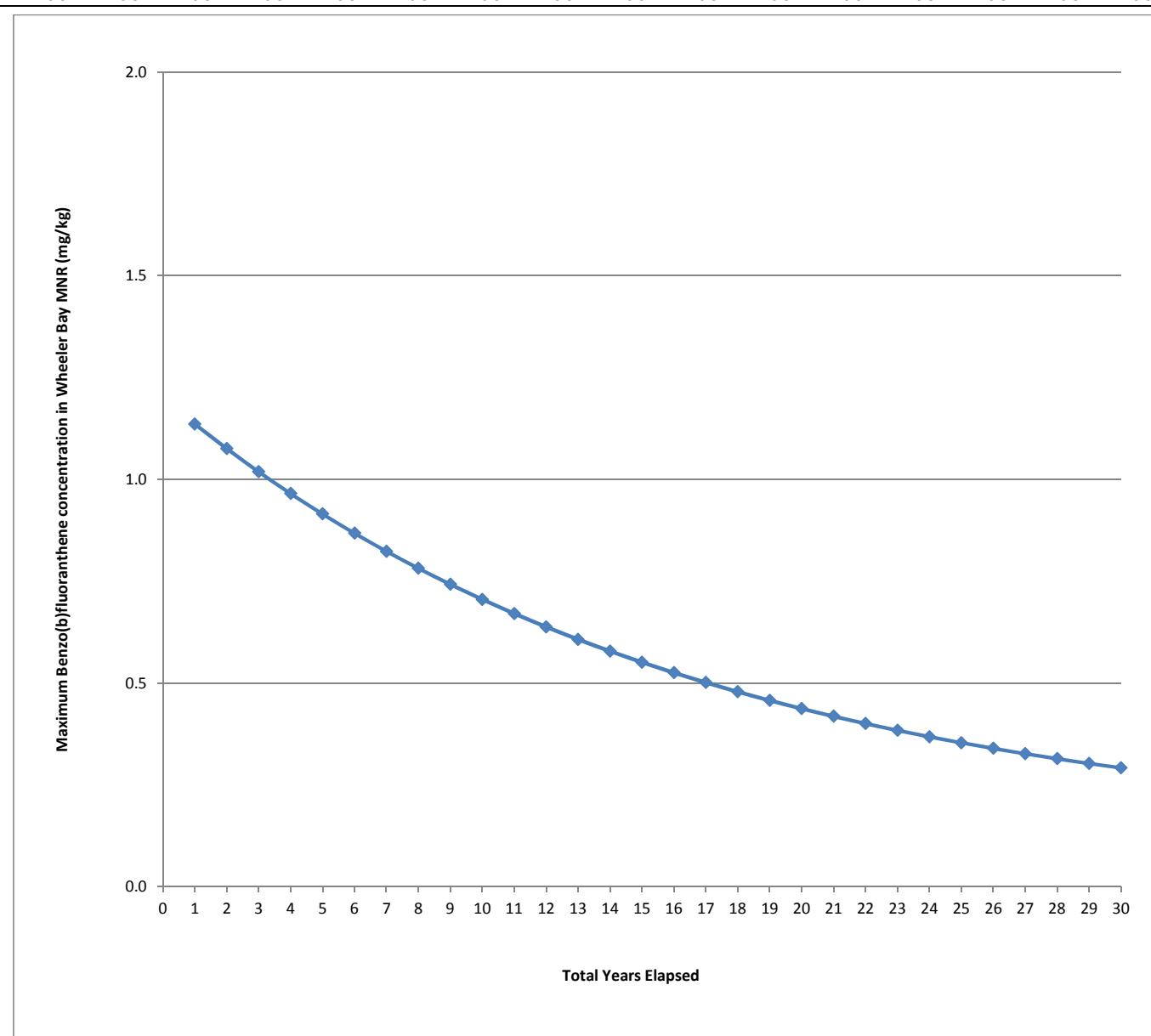
Appendix B: SEDCAM Model Output
Wheeler Bay MNR Area - Benzo(b)fluoranthene

Estimate recontamination in Wheeler

Bay MNR Area Benzo(b)fluoranthene FROM MAX

Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Benzo(b)fluoranthene at any point in Wheeler Bay MNR, $C_c(t)$	1.14	1.08	1.02	0.97	0.92	0.87	0.82	0.78	0.74	0.71	0.67	0.64	0.61	0.58	0.55	0.53	0.50	0.48	0.46	0.44	0.42	0.40	0.38	0.37	0.35	0.34	0.33	0.31	0.30	0.29 mg/kg
Mixing Layer thickness, ML	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00 cm	
Mass/Area, R_s	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92 g/cm ²	
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹	
Initial Concentration, C_0	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3 ug/kg		
Input Concentration, C_p	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1 ug/kg		
Time step elapsed, t	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00 yr		
Ts = ML/R _s	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34		
1+kTs	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
e ^{-(1+kTs)t/Ts}	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94		
Total load of COPC	0.020 kg/yr																													
Total load of sediment	166,306 kg/yr																													
Concentration of input	0.12 mg/kg																													
R _s = mass/area	0.918 g/cm ²																													
Total Area	195,000 ft ²																													
Total Mass Load	166,306 kg/yr																													

Assumes mixing occur in 15cm (~half a foot).



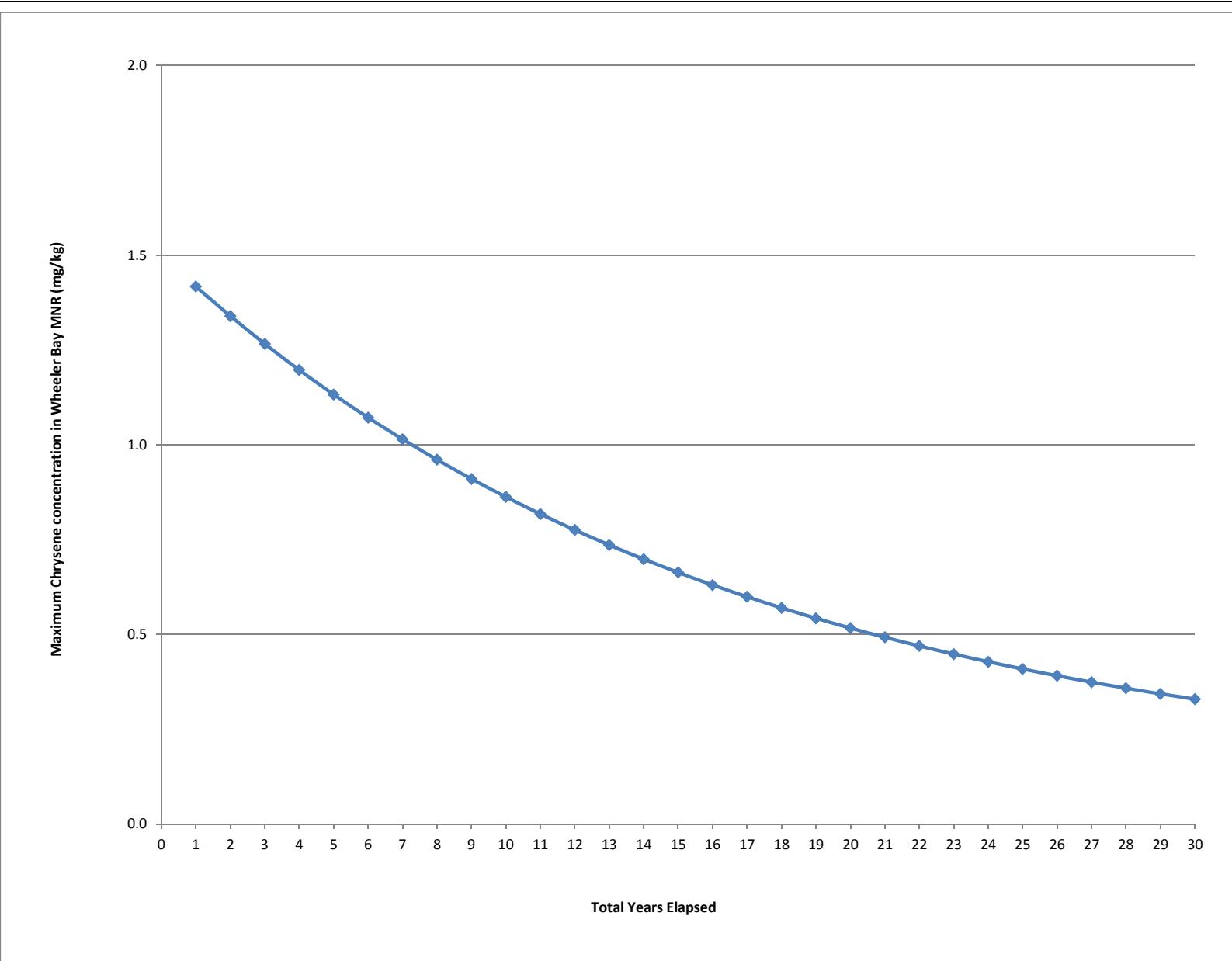
Appendix B: SEDCAM Model Output
Wheeler Bay MNR Area - Chrysene

Estimate recontamination in Wheeler Bay

MNR Area **Chrysene FROM MAX**

Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Maximum concentration of Chrysene at any point in Wheeler Bay MNR, $C_t(t)$	1.42	1.34	1.27	1.20	1.13	1.07	1.01	0.96	0.91	0.86	0.82	0.78	0.74	0.70	0.66	0.63	0.60	0.57	0.54	0.52	0.49	0.47	0.45	0.43	0.41	0.39	0.37	0.36	0.34	0.33 mg/kg
Mixing Layer thickness, ML	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00 cm	
Mass/Area, R_s	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92 g/cm ²	
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹	
Initial Concentration, C_0	1.5	1.4	1.3	1.3	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.7	0.6	0.6	0.6	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.3 ug/kg		
Input Concentration, C_p	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1 ug/kg		
Time step elapsed, t	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00 yr			
Ts = ML/R _s	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34			
1+kTs	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
e ^{-(1+kTs)t/Ts}	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94			
Total load of COPC	0.018 kg/yr																													
Total load of sediment	166,306 kg/yr																													
Concentration of input	0.11 mg/kg																													
R _s = mass/area	0.918 g/cm ²																													
Total Area	195,000 ft ²																													
Total Mass Load	166,306 kg/yr																													

Assumes mixing occur in 15cm (~half a foot).



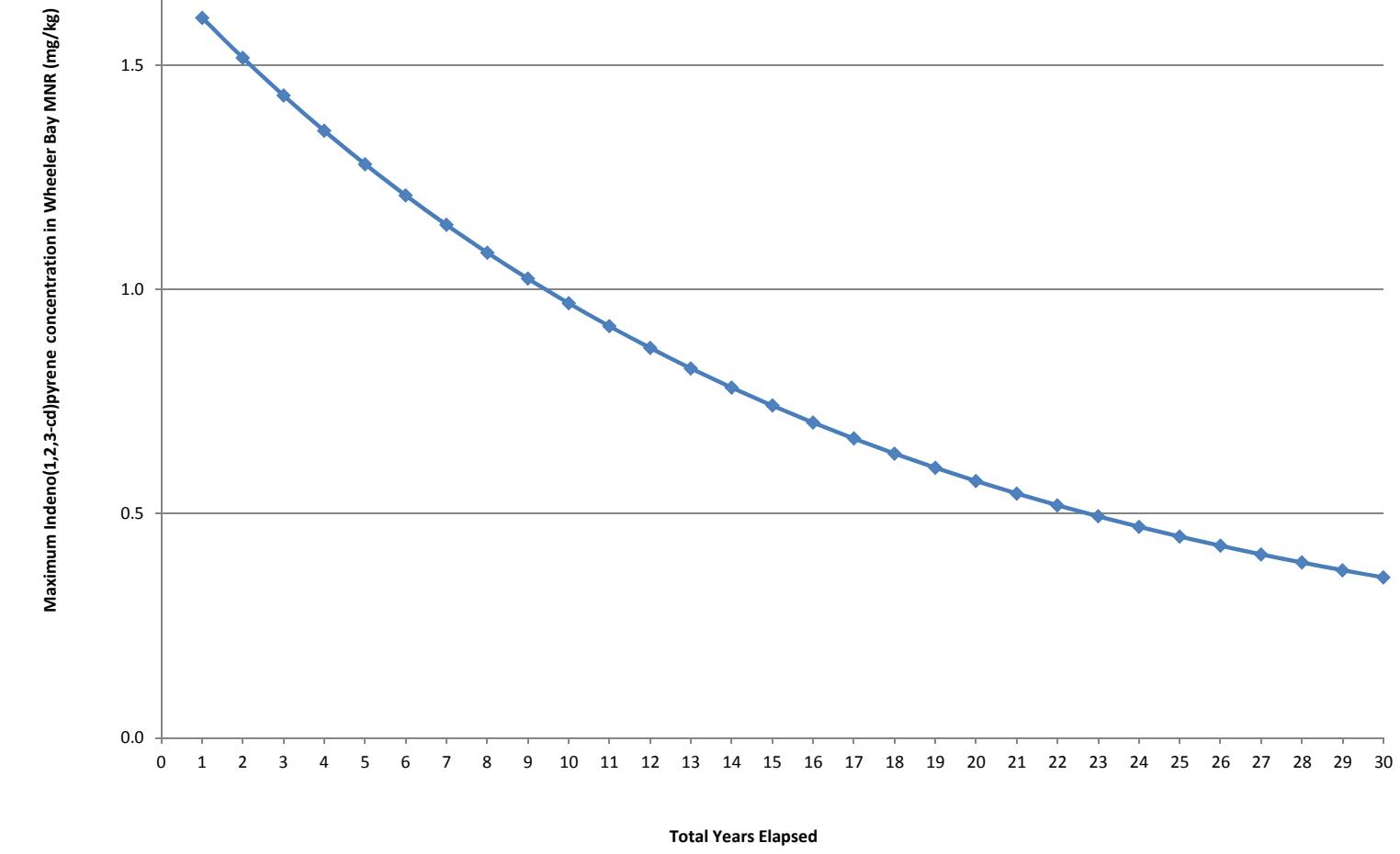
Appendix B: SEDCAM Model Output
Wheeler Bay MNR Area - Indeno(1,2,3-cd)pyrene

Estimate recontamination in Wheeler Bay

MNR Area Indeno(1, FROM MAX

Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Maximum concentration of Indeno(1,2,3-cd)pyrene at any point in Wheeler Bay MNR,																														
C _c (t)	1.61	1.52	1.43	1.35	1.28	1.21	1.14	1.08	1.02	0.97	0.92	0.87	0.82	0.78	0.74	0.70	0.67	0.63	0.60	0.57	0.54	0.52	0.49	0.47	0.45	0.43	0.41	0.39	0.37	0.36 mg/kg
Mixing Layer thickness, ML	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00 cm		
Mass/Area, R _s	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92 g/cm ²		
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹		
Initial Concentration, C _o	1.7	1.6	1.5	1.4	1.4	1.3	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4 ug/kg		
Input Concentration, C _p	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1 ug/kg		
Time step elapsed, t	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00 yr			
T _s = ML/R _s	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34			
1+kT _s	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
e ^{-(1+kT_s)t/T_s}	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94			
Total load of COPC	0.017 kg/yr																													
Total load of sediment	166,306 kg/yr																													
Concentration of input	0.10 mg/kg																													
R _s = mass/area	0.918 g/cm ²																													
Total Area	195,000 ft ²																													
Total Mass Load	166,306 kg/yr																													

Assumes mixing occur in 15cm (~half a foot).



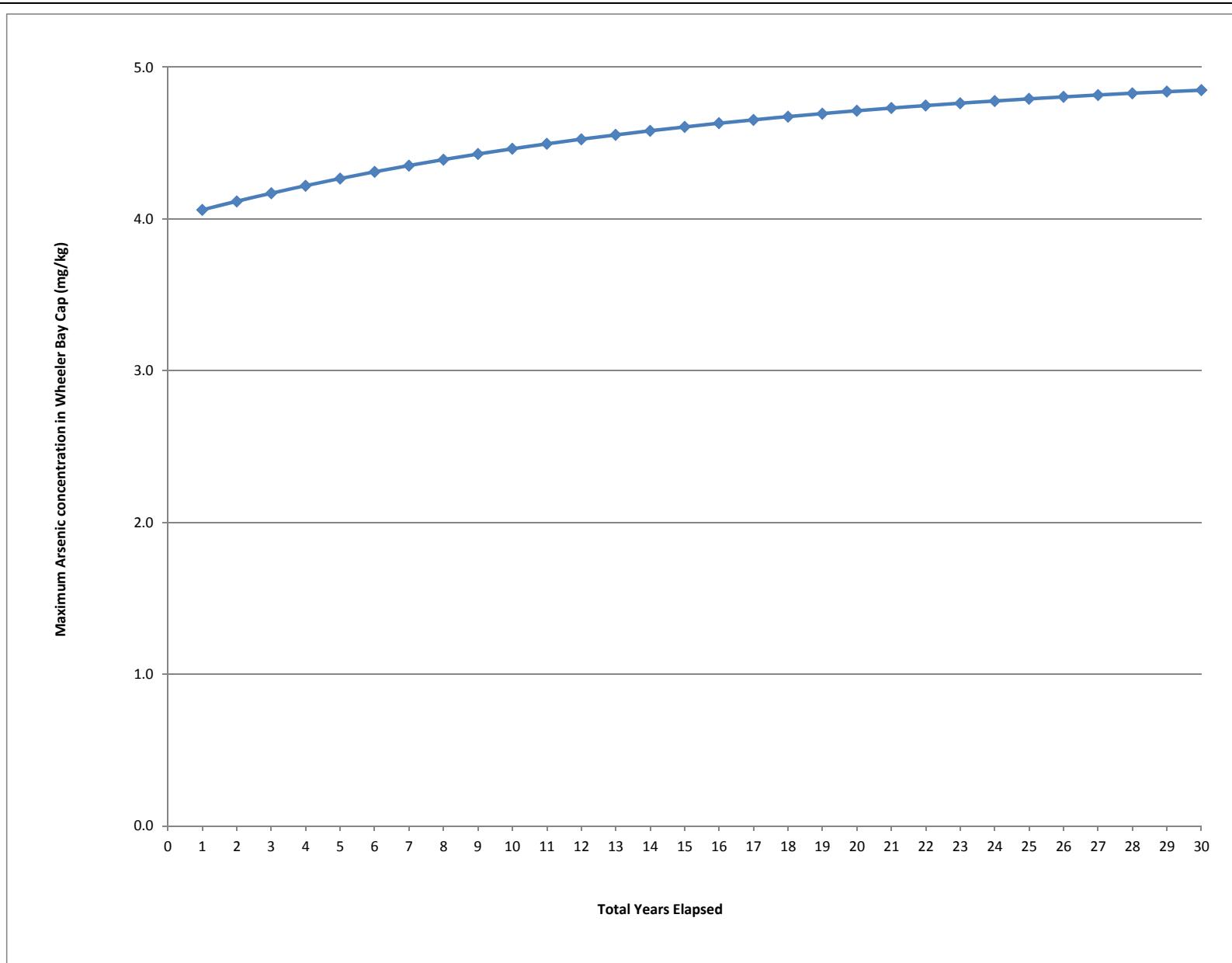
Appendix B: SEDCAM Model Output
Wheeler Bay Cap Area (Pre-Cap Conditions) - Arsenic

Estimate recontamination in Wheeler Bay

Cap Area Arsenic FROM MAX

Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Maximum concentration of Arsenic at any point in Wheeler Bay Cap, $C_c(t)$	4.06	4.12	4.17	4.22	4.27	4.31	4.35	4.39	4.43	4.46	4.49	4.53	4.55	4.58	4.61	4.63	4.65	4.67	4.69	4.71	4.73	4.75	4.76	4.78	4.79	4.80	4.82	4.83	4.84	4.85 mg/kg
Mixing Layer thickness, ML	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00 cm	
Mass/Area, R_s	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92 g/cm ²		
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹	
Initial Concentration, C_0	4.0	4.1	4.1	4.2	4.2	4.3	4.3	4.4	4.4	4.4	4.5	4.5	4.6	4.6	4.6	4.6	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.8	4.8	4.8	4.8	4.8 ug/kg		
Input Concentration, C_p	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0 ug/kg		
Time step elapsed, t	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00 yr			
$T_s = ML/R_s$	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34		
$1+kT_s$	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
$e^{-(1+kT_s)t/T_s}$	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94			
Total load of COPC	0.363 kg/yr																													
Total load of sediment	72,492 kg/yr																													
Concentration of input	5.01 mg/kg																													
$R_s = \text{mass/area}$	0.918 g/cm ²																													
Total Area	85,000 ft ²																													
Total Mass Load	72,492 kg/yr																													

Assumes mixing occur in 15cm (~half a foot).



Appendix B: SEDCAM Model Output
Wheeler Bay Cap (Pre-Cap Conditions) - Benzo(a)pyrene

Estimate recontamination in

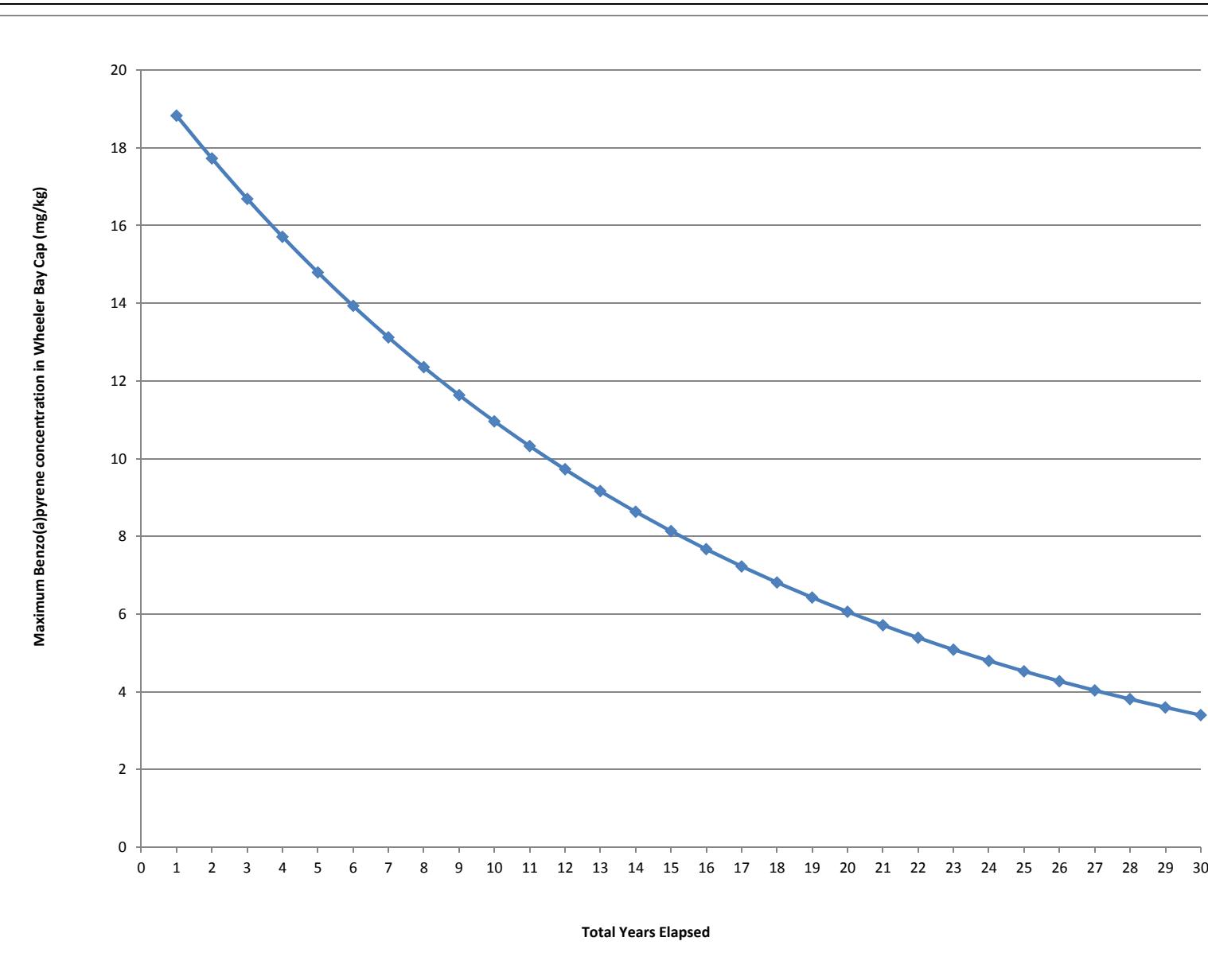
Wheeler Bay Cap Area

Benzo(a)pyrene

FROM MAX

Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Benzo(a)pyrene at any point in Wheeler Bay Cap, C _c (t)	18.83	17.73	16.69	15.71	14.79	13.93	13.12	12.36	11.64	10.96	10.33	9.73	9.17	8.64	8.14	7.67	7.23	6.82	6.43	6.06	5.71	5.39	5.09	4.80	4.53	4.28	4.04	3.81	3.60	3.40 mg/kg
Mixing Layer thickness, ML	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00 cm		
Mass/Area, R _s	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92 g/cm ²			
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹		
Initial Concentration, C _o	20.0	18.8	17.7	16.7	15.7	14.8	13.9	13.1	12.4	11.6	11.0	10.3	9.7	9.2	8.6	8.1	7.7	7.2	6.8	6.4	6.1	5.7	5.4	5.1	4.8	4.5	4.3	4.0	3.8 ug/kg	
Input Concentration, C _p	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3 ug/kg		
Time step elapsed, t	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00 yr			
T _s = ML/R _s	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34			
1+kT _s	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
e ^{-(1+kT_s)t/T_s}	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94		
Total load of COPC	0.018 kg/yr																													
Total load of sediment	72,492 kg/yr																													
Concentration of input	0.25 mg/kg																													
R _s = mass/area	0.918 g/cm ²																													
Total Area	85,000 ft ²																													
Total Mass Load	72,492 kg/yr																													

Assumes mixing occur in 15cm (~half a foot).



Appendix B: SEDCAM Model Output
Wheeler Bay Cap Area (Pre-Cap Conditions) - Benzo(b)fluoranthene

Estimate recontamination in Wheeler

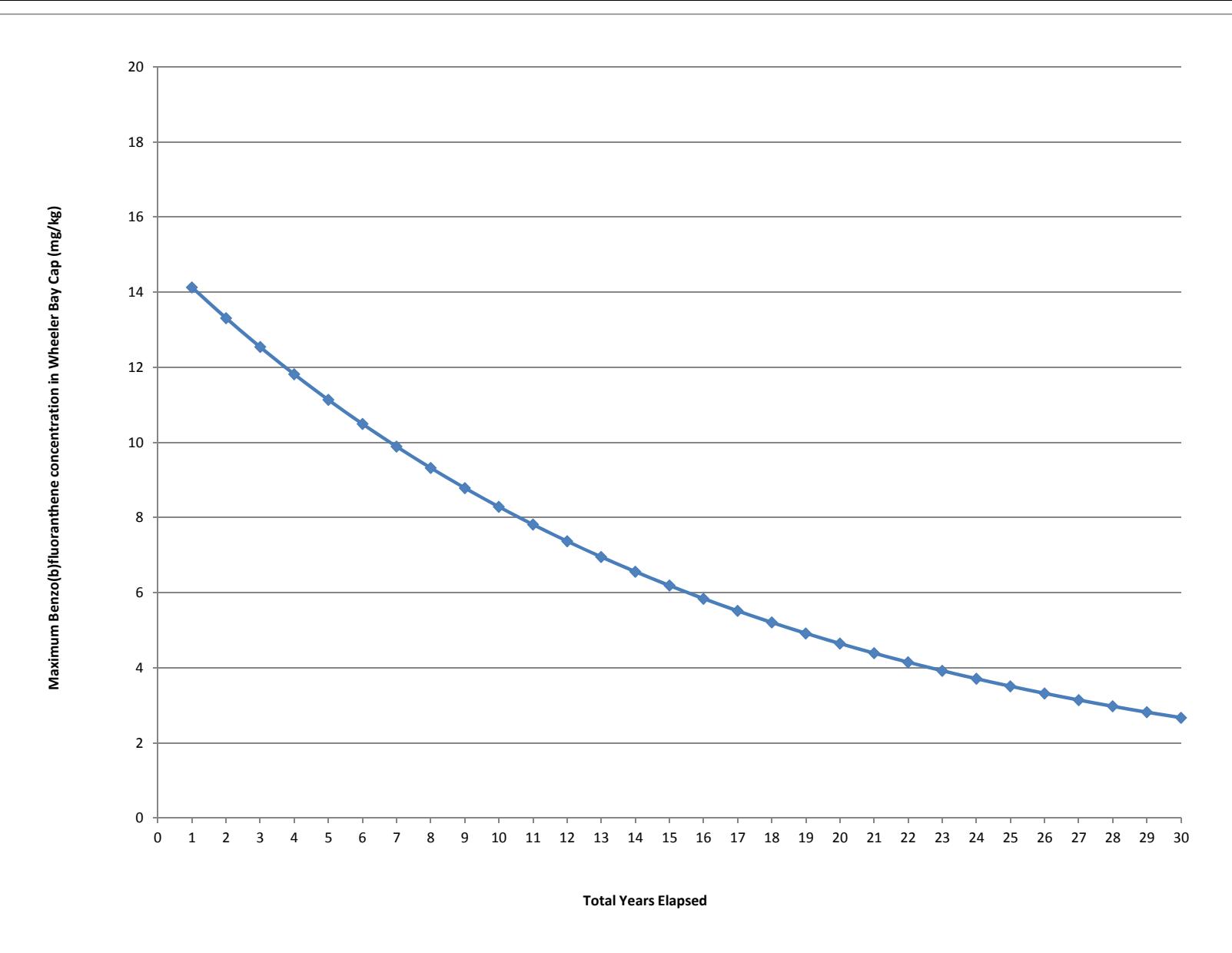
Bay Cap Area Benzo(b)f FROM MAX

Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Benzo(b)fluoranthene at any point in Wheeler Bay Cap, C _c (t)	14.13	13.31	12.54	11.82	11.13	10.49	9.89	9.32	8.79	8.29	7.81	7.37	6.95	6.56	6.19	5.84	5.51	5.21	4.92	4.65	4.39	4.15	3.92	3.71	3.51	3.32	3.14	2.98	2.82	2.67 mg/kg
Mixing Layer thickness, ML	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00 cm	
Mass/Area, R _s	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92 g/cm ²		
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹	
Initial Concentration, C _o	15.0	14.1	13.3	12.5	11.8	11.1	10.5	9.9	9.3	8.8	8.3	7.8	7.4	7.0	6.6	6.2	5.8	5.5	5.2	4.9	4.6	4.4	4.1	3.9	3.7	3.5	3.3	3.1	3.0 ug/kg	
Input Concentration, C _p	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3 ug/kg		
Time step elapsed, t	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00 yr		
T _s = ML/R _s	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34		
1+kT _s	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
e ^{-(1+kT_s)t/T_s}	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94		

Total load of COPC 0.024 kg/yr
 Total load of sediment 72,492 kg/yr
 Concentration of input 0.33 mg/kg

R_s = mass/area 0.918 g/cm²
 Total Area 85,000 ft²
 Total Mass Load 72,492 kg/yr

Assumes mixing occur in 15cm (~half a foot).

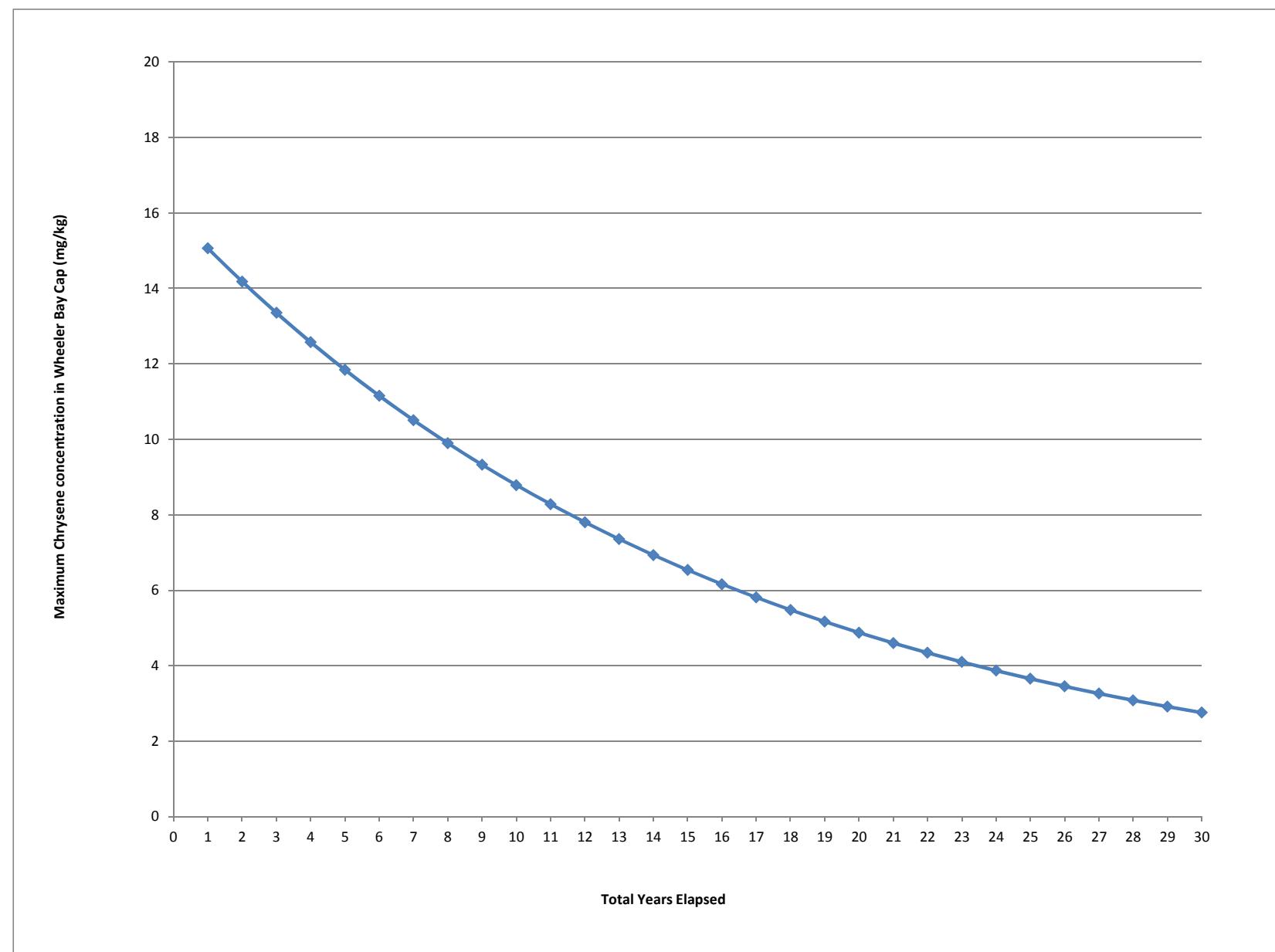


Appendix B: SEDCAM Model Output Wheeler Bay Cap Area (Pre-Cap Conditions) - Chrysene

Estimate recontamination in Wheeler Bay

Cap Area **Chrysene FROM MAX**

Assumes mixing occur in 15cm (~half a foot).



Appendix B: SEDCAM Model Output
Wheeler Bay Cap Area (Pre-Cap Conditions) - Indeno(1,2,3-cd)pyrene

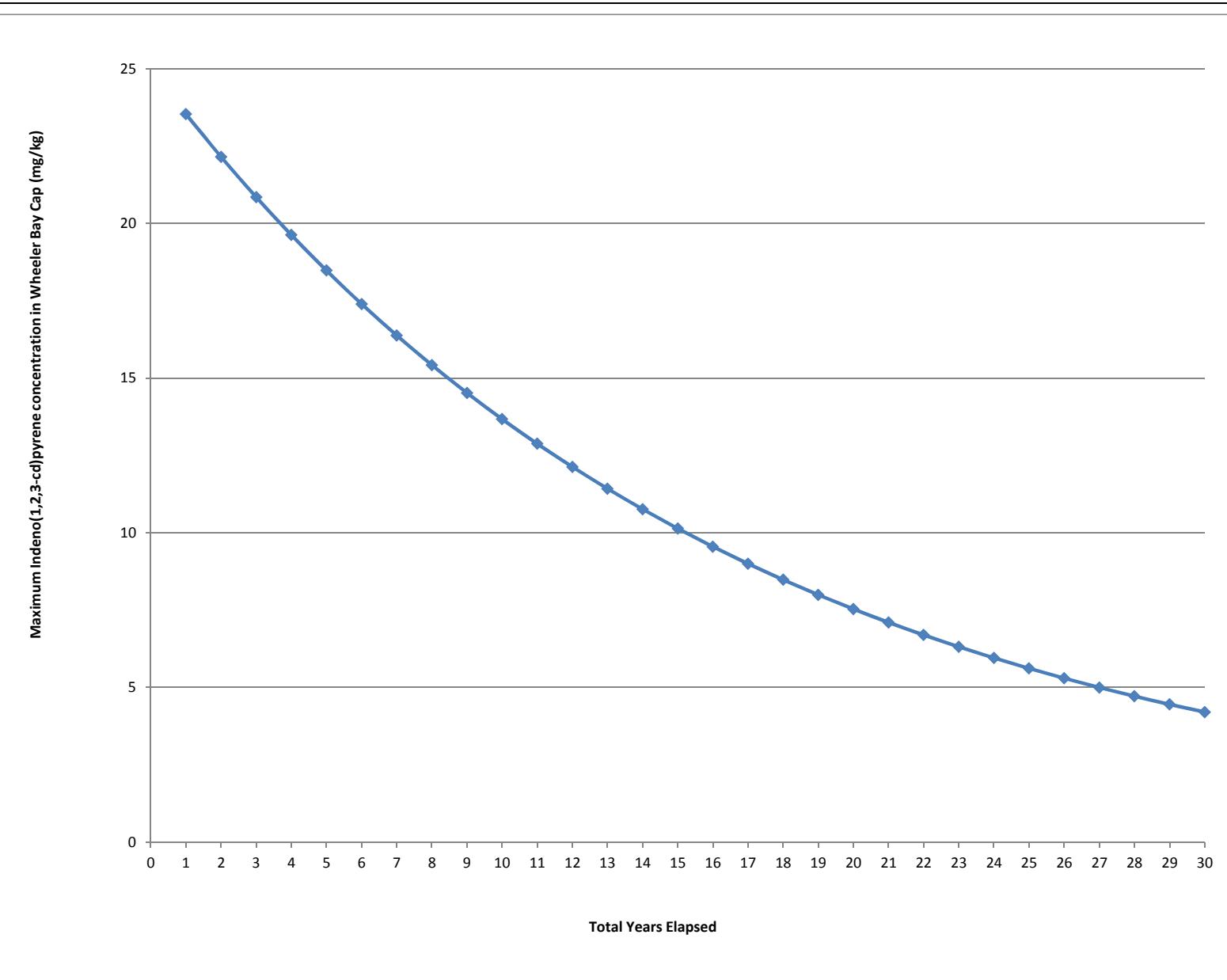
Estimate recontamination in

Wheeler Bay Cap Area

Indeno(1, FROM MAX

Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Indeno(1,2,3-cd)pyrene at any point in Wheeler Bay Cap, C _c (t)	23.53	22.15	20.85	19.63	18.48	17.40	16.38	15.42	14.52	13.68	12.88	12.13	11.43	10.76	10.14	9.55	9.00	8.48	7.99	7.53	7.10	6.70	6.31	5.96	5.62	5.30	5.00	4.72	4.45	4.20 mg/kg
Mixing Layer thickness, ML	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00 cm	
Mass/Area, R _s	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92 g/cm ²		
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹	
Initial Concentration, C _o	25.0	23.5	22.1	20.9	19.6	18.5	17.4	16.4	15.4	14.5	13.7	12.9	12.1	11.4	10.8	10.1	9.6	9.0	8.5	8.0	7.5	7.1	6.7	6.3	6.0	5.6	5.3	5.0	4.7	4.5 ug/kg
Input Concentration, C _p	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3 ug/kg	
Time step elapsed, t	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00 yr	
T _s = ML/R _s	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34		
1+kT _s	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
e ^{-(1+kT_s)t/T_s}	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	
Total load of COPC	0.019 kg/yr																													
Total load of sediment	72,492 kg/yr																													
Concentration of input	0.26 mg/kg																													
R _s = mass/area	0.918 g/cm ²																													
Total Area	85,000 ft ²																													
Total Mass Load	72,492 kg/yr																													

Assumes mixing occur in 15cm (~half a foot).



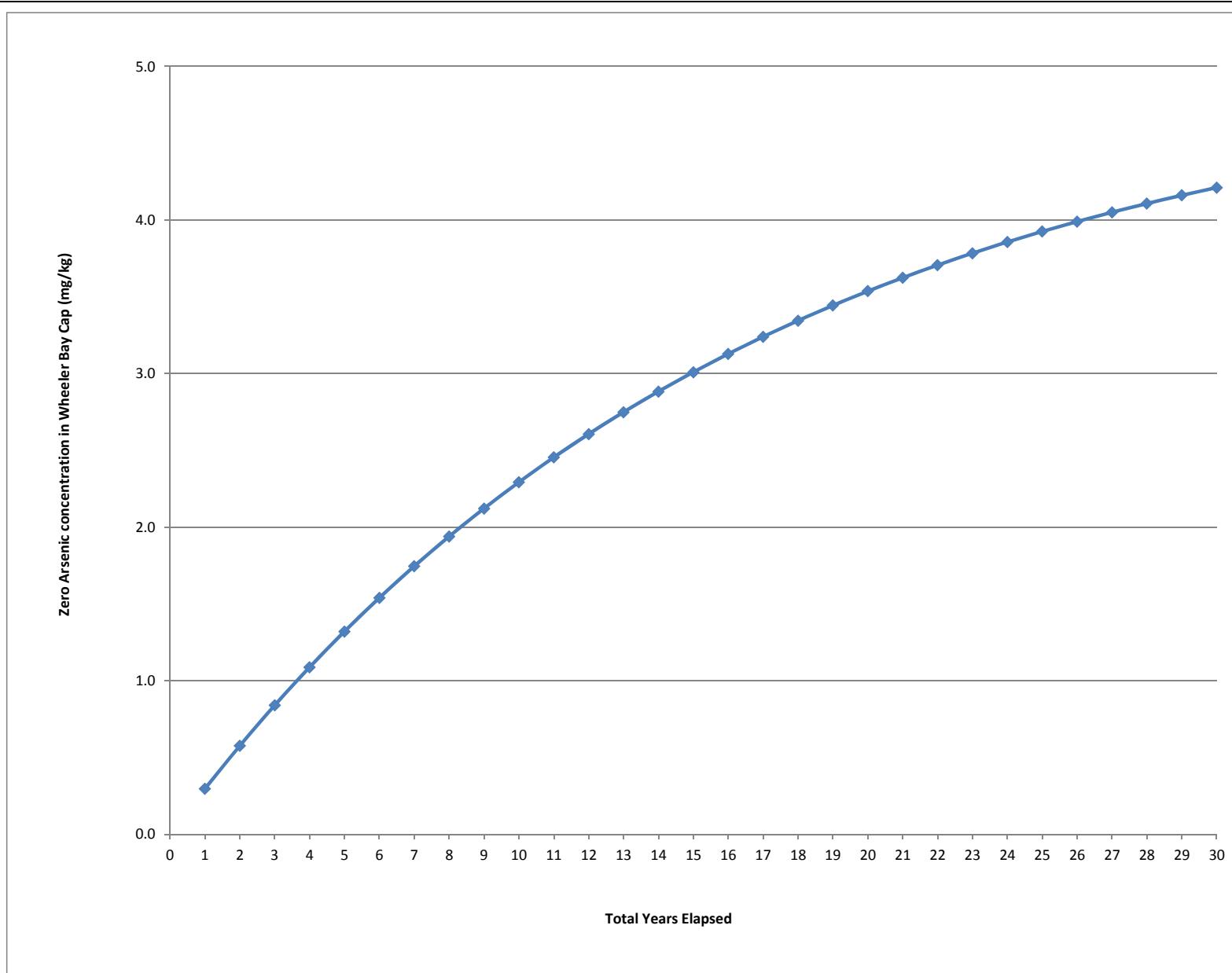
Appendix B: SEDCAM Model Output
Wheeler Bay Cap Area (Assuming Cap Conditions) - Arsenic

Estimate recontamination in Wheeler Bay

Cap Area Arsenic FROM MAX

Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Maximum concentration of Arsenic at any point in Wheeler Bay Cap, $C_c(t)$	0.30	0.58	0.84	1.09	1.32	1.54	1.75	1.94	2.12	2.29	2.45	2.61	2.75	2.88	3.01	3.13	3.24	3.34	3.44	3.54	3.62	3.71	3.78	3.86	3.93	3.99	4.05	4.11	4.16	4.21 mg/kg
Mixing Layer thickness, ML	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00 cm		
Mass/Area, R_s	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92 g/cm ²			
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹		
Initial Concentration, C_0	0.0	0.3	0.6	0.8	1.1	1.3	1.5	1.7	1.9	2.1	2.3	2.5	2.6	2.7	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	3.9	4.0	4.1	4.1 ug/kg	
Input Concentration, C_p	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0 ug/kg		
Time step elapsed, t	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00 yr			
$T_s = ML/R_s$	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34			
$1+kT_s$	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
$e^{-(1+kT_s)t/T_s}$	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94			
Total load of COPC	0.363 kg/yr																													
Total load of sediment	72,492 kg/yr																													
Concentration of input	5.01 mg/kg																													
$R_s = \text{mass/area}$	0.918 g/cm ²																													
Total Area	85,000 ft ²																													
Total Mass Load	72,492 kg/yr																													

Assumes mixing occur in 15cm (~half a foot).



Appendix B: SEDCAM Model Output
Wheeler Bay Cap Area (Assuming Cap Conditions) - Benzo(a)pyrene

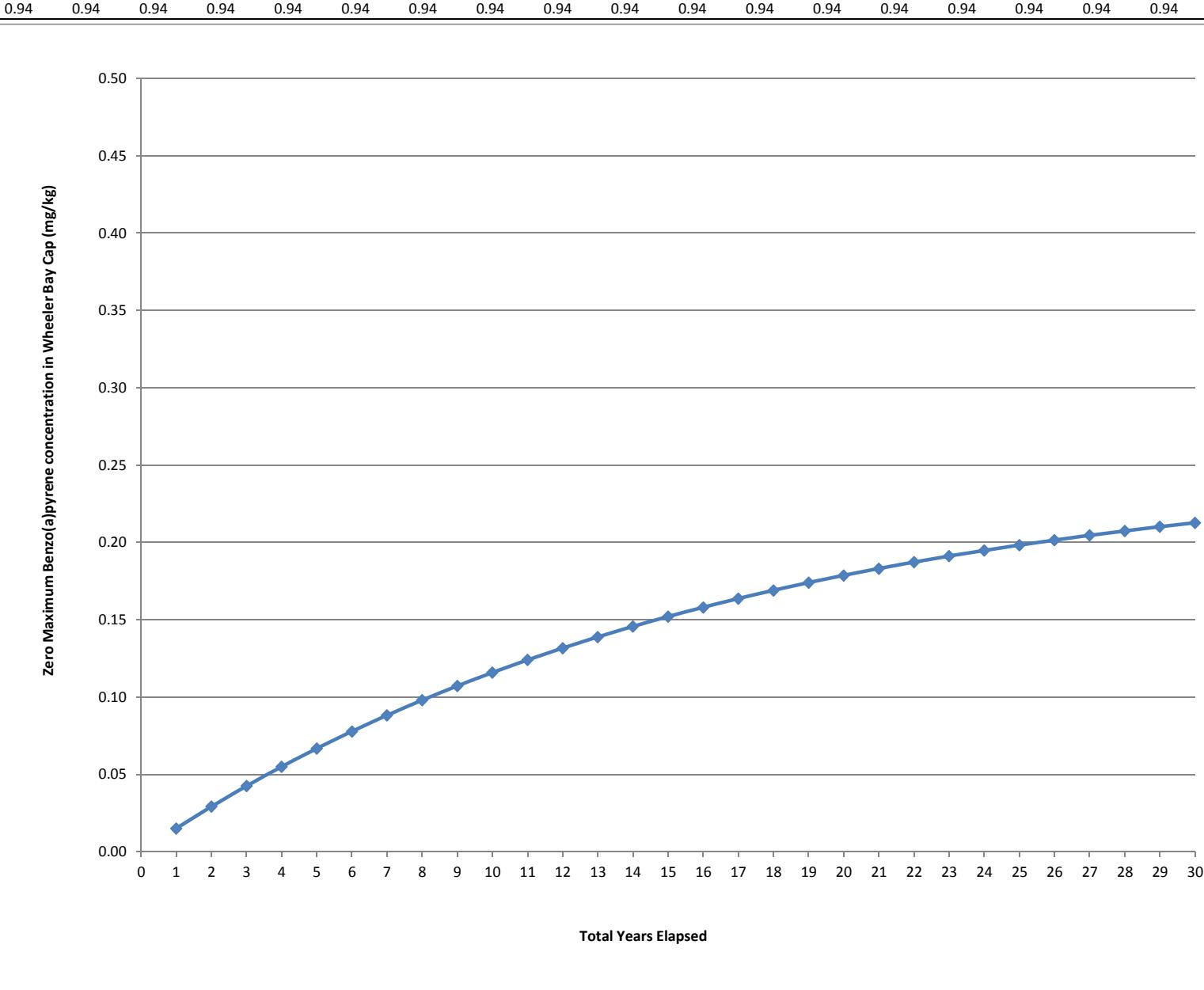
Estimate recontamination in

Wheeler Bay Cap Area

Benzo(a)P FROM MAX

Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Benzo(a)pyrene at any point in Wheeler Bay Cap, C _c (t)	0.02	0.03	0.04	0.05	0.07	0.08	0.09	0.10	0.11	0.12	0.12	0.13	0.14	0.15	0.15	0.16	0.16	0.17	0.17	0.18	0.18	0.19	0.19	0.20	0.20	0.20	0.21	0.21	0.21 mg/kg	
Mixing Layer thickness, ML	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00 cm		
Mass/Area, R _s	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92 g/cm ²			
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹		
Initial Concentration, C _o	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2 ug/kg		
Input Concentration, C _p	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3 ug/kg		
Time step elapsed, t	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00 yr			
T _s = ML/R _s	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34			
1+kT _s	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
e ^{-(1+kT_s)t/T_s}	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94			
Total load of COPC	0.018 kg/yr																													
Total load of sediment	72,492 kg/yr																													
Concentration of input	0.25 mg/kg																													
R _s = mass/area	0.918 g/cm ²																													
Total Area	85,000 ft ²																													
Total Mass Load	72,492 kg/yr																													

Assumes mixing occur in 15cm (~half a foot).



Appendix B: SEDCAM Model Output
Wheeler Bay Cap Area (Assuming Cap Conditions) - Benzo(b)fluoranthene

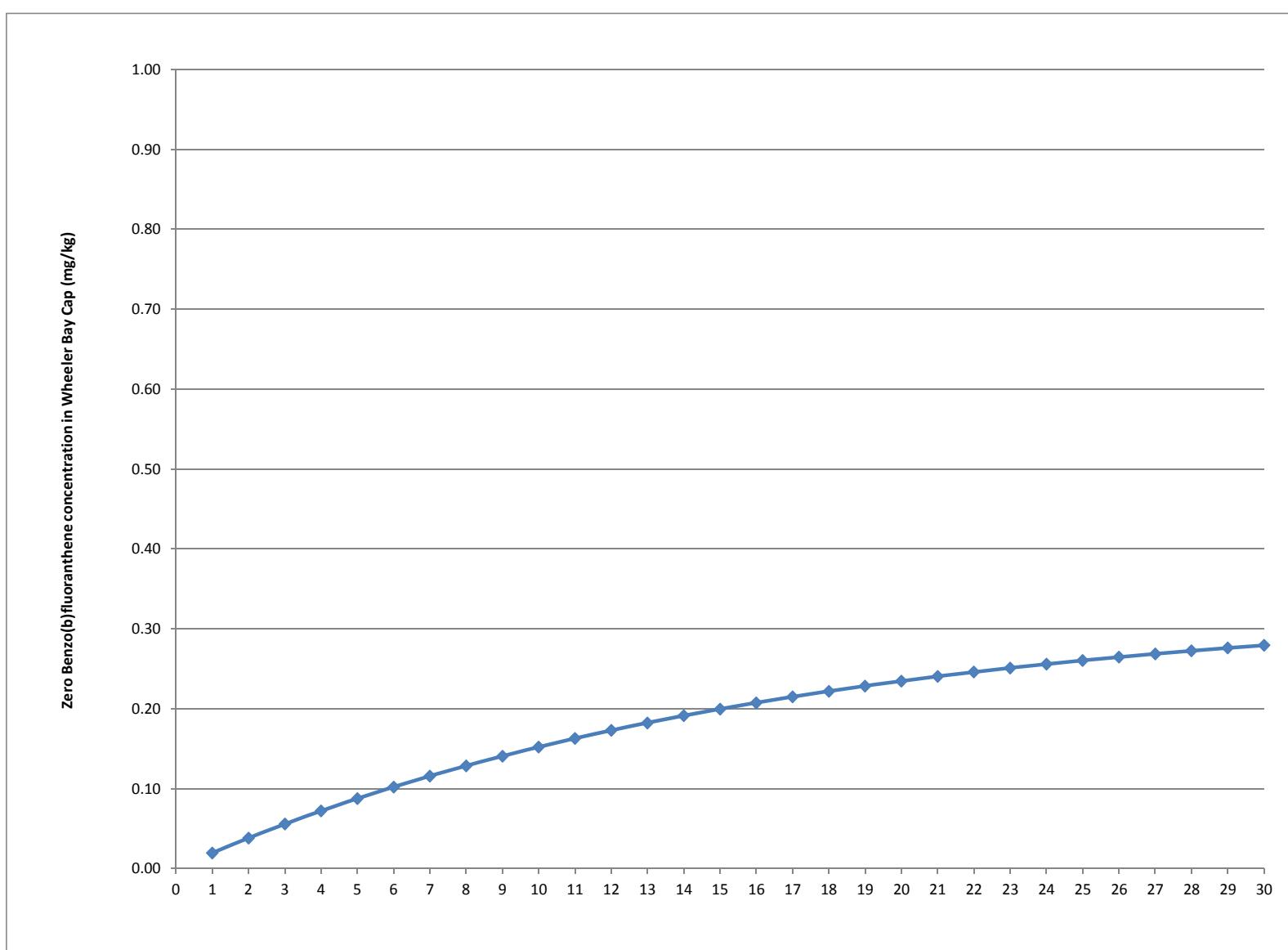
Estimate recontamination in Wheeler

Bay Cap Area Benzo(b)f FROM MAX

Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Benzo(b)fluoranthene at any point in Wheeler Bay Cap, C _c (t)	0.02	0.04	0.06	0.07	0.09	0.10	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.23	0.24	0.25	0.25	0.26	0.26	0.26	0.27	0.27	0.28	0.28 mg/kg	
Mixing Layer thickness, ML	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00 cm		
Mass/Area, R _s	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92 g/cm ²			
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹		
Initial Concentration, C ₀	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3 ug/kg		
Input Concentration, C _p	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3 ug/kg		
Time step elapsed, t	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00 yr			
T _s = ML/R _s	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34			
1+kT _s	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
e ^{-(1+kT_s)t/T_s}	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94			
Total load of COPC	0.024 kg/yr																													
Total load of sediment	72,492 kg/yr																													
Concentration of input	0.33 mg/kg																													
R _s = mass/area	0.918 g/cm ²																													
Total Area	85,000 ft ²																													
Total Mass Load	72,492 kg/yr																													

Assumes mixing occur in 15cm (~half a foot).

Zero Benzo(b)fluoranthene concentration in Wheeler Bay Cap (mg/kg)



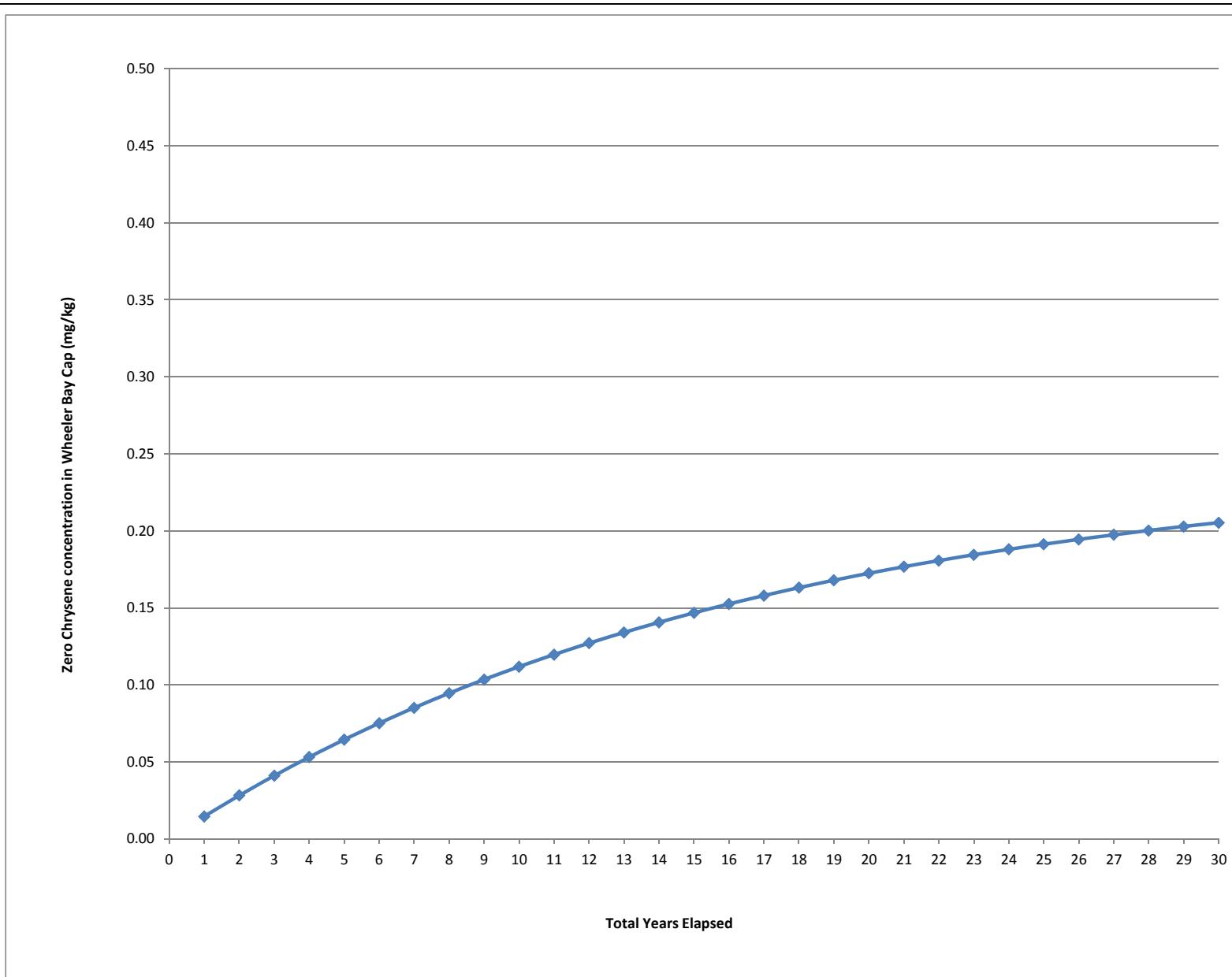
Appendix B: SEDCAM Model Output
Wheeler Bay Cap Area (Assuming Cap Conditions) - Chrysene

Estimate recontamination in Wheeler Bay

Cap Area Chrysene FROM MAX

Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Maximum concentration of Chrysene at any point in Wheeler Bay Cap, $C_e(t)$	0.01	0.03	0.04	0.05	0.06	0.08	0.09	0.09	0.10	0.11	0.12	0.13	0.13	0.14	0.15	0.15	0.16	0.16	0.17	0.17	0.18	0.18	0.18	0.19	0.19	0.19	0.20	0.20	0.21 mg/kg	
Mixing Layer thickness, ML	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00 cm	
Mass/Area, R_s	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92 g/cm ²		
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹	
Initial Concentration, C_o	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2 ug/kg		
Input Concentration, C_p	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2 ug/kg		
Time step elapsed, t	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00 yr			
Ts = ML/R _s	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34		
1+kTs	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
e ^{(-1+kTs)t/Ts}	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94		
Total load of COPC	0.018 kg/yr																													
Total load of sediment	72,492 kg/yr																													
Concentration of input	0.24 mg/kg																													
R_s = mass/area	0.918 g/cm ²																													
Total Area	85,000 ft ²																													
Total Mass Load	72,492 kg/yr																													

Assumes mixing occur in 15cm (~half a foot).



Appendix B: SEDCAM Model Output
Wheeler Bay Cap Area (Assuming Cap Conditions) - Indeno(1,2,3-cd)pyrene

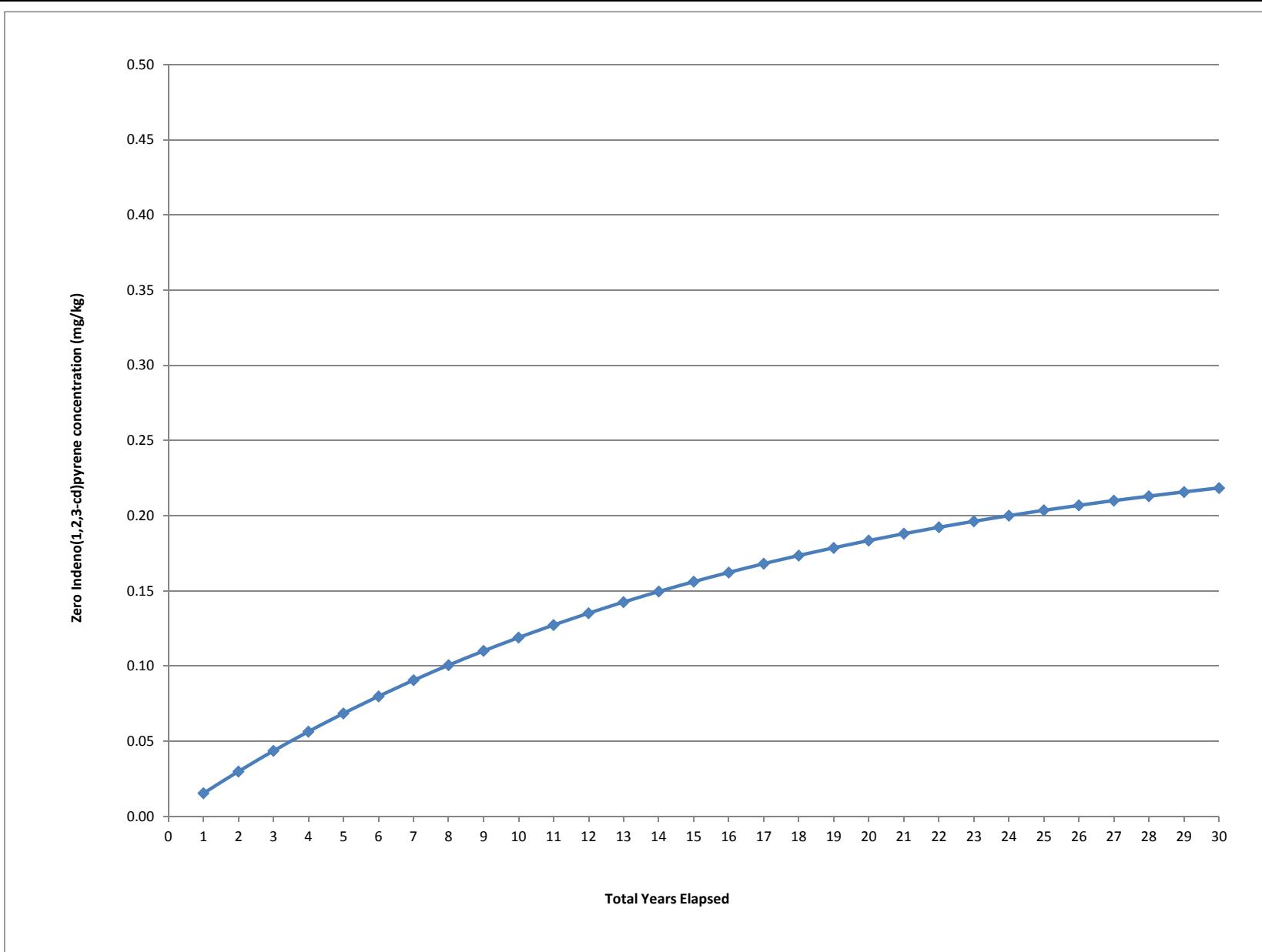
Estimate recontamination in

Wheeler Bay Cap Area

Indeno(1,2,3-cd)pyr FROM MAX

Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Indeno(1,2,3-cd)pyrene at any point in Wheeler Bay Cap, $C_c(t)$	0.02	0.03	0.04	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.14	0.15	0.16	0.16	0.17	0.17	0.18	0.18	0.19	0.19	0.20	0.20	0.21	0.21	0.21	0.22 mg/kg		
Mixing Layer thickness, ML	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00 cm		
Mass/Area, R_s	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92 g/cm ²			
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹		
Initial Concentration, C_o	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2 ug/kg			
Input Concentration, C_p	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3 ug/kg			
Time step elapsed, t	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00 yr				
Ts = ML/R _s	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34			
1+kTs	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
e ^{-(1+kTs)t/Ts}	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94			
Total load of COPC	0.019 kg/yr																													
Total load of sediment	72,492 kg/yr																													
Concentration of input	0.26 mg/kg																													
R_s = mass/area	0.918 g/cm ²																													
Total Area	85,000 ft ²																													
Total Mass Load	72,492 kg/yr																													

Assumes mixing occur in 15cm (~half a foot).



APPENDIX C

Sensitivity Analysis Model Outputs

Appendix C: Sensitivity Analysis Model Outputs
Wheeler Bay MNR Area - Benzo(a)pyrene - Varying Stormwater COI Concentration

**Estimate recontamination in Wheeler Bay MNR
Area -ORIGINAL COI CONC IN STORMWATER**

SOLIDS	Benzo(a)pyrene		FROM MAX																											
Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Maximum concentration of Benzo(a)pyrene at any point in Wheeler Bay MNR, C _c (t)	1.61	1.52	1.43	1.35	1.28	1.21	1.14	1.08	1.03	0.97	0.92	0.87	0.83	0.78	0.74	0.71	0.67	0.64	0.60	0.58	0.55	0.52	0.50	0.47	0.45	0.43	0.41	0.39	0.38	0.36 mg/kg
Mixing Layer thickness, ML	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00 cm		
Mass/Area, R _s	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92 g/cm ²		
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹		
Initial Concentration, C ₀	1.7	1.6	1.5	1.4	1.4	1.3	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4 ug/kg			
Input Concentration, C _p	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1 ug/kg			
Time step elapsed, t	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00 yr				
Ts = ML/R _s	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34				
1+kTs	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00				
e ^{-(1+kTs)t/Ts}	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94				
Spring 2010 PRG for Lead	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91			
Total load of COPC	0.018 kg/yr																													
Total load of sediment	166,306 kg/yr																													
Concentration of input	0.11 mg/kg																													
R _s = mass/area	0.918 g/cm ²																													
Total Area	195,000 ft ²																													
Total Mass Load	166,306 kg/yr																													

Assumes mixing occur in 15cm (~half a foot).

**Estimate recontamination in Wheeler Bay MNR
Area - TWICE THE COI CONC IN STORMWATER**

SOLIDS	Benzo(a)pyrene		FROM MAX																											
Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Maximum concentration of Benzo(a)pyrene at any point in Wheeler Bay MNR, C _c (t)	1.60786	1.52119	1.43966	1.36298	1.29085	1.22299	1.15917	1.09914	1.04267	0.98955	0.93959	0.89259	0.84838	0.8068	0.76768	0.73089	0.69628	0.66372	0.6331	0.6043	0.5772	0.55172	0.52775	0.5052	0.48399	0.464	0.44527	0.42761	0.411	0.3954 mg/kg
Mixing Layer thickness, ML	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15 cm	
Mass/Area, R _s	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918 g/cm ²			
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹		
Initial Concentration, C ₀	1.7	1.60786	1.52119	1.43966	1.36298	1.29085	1.22299	1.15917	1.09914	1.04267	0.98955	0.93959	0.89259	0.84838	0.8068	0.76768	0.73089	0.69628	0.66372	0.6331	0.6043	0.5772	0.55172	0.5277	0.5052	0.484	0.46403	0.44527	0.4276	0.411 ug/kg
Input Concentration, C _p	0.1479	0.1479	0.1479	0.1479	0.1479	0.1479	0.1479	0.1479	0.1479	0.1479	0.1479	0.1479	0.1479	0.1479	0.1479	0.1479	0.1479	0.1479	0.1479	0.1479	0.1479	0.1479	0.1479	0.1479	0.1479	0.1479	0.1479 ug/kg			
Time step elapsed, t	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1 yr		
Ts = ML/R _s	16.3399	16.3399	1																											

Appendix C: Sensitivity Analysis Model Outputs
Wheeler Bay MNR Area - Benzo(a)pyrene - Varying Stormwater COI Concentration

Estimate recontamination in Wheeler Bay MNR

Area - HALF THE COI CONC IN STORMWATER

SOLIDS

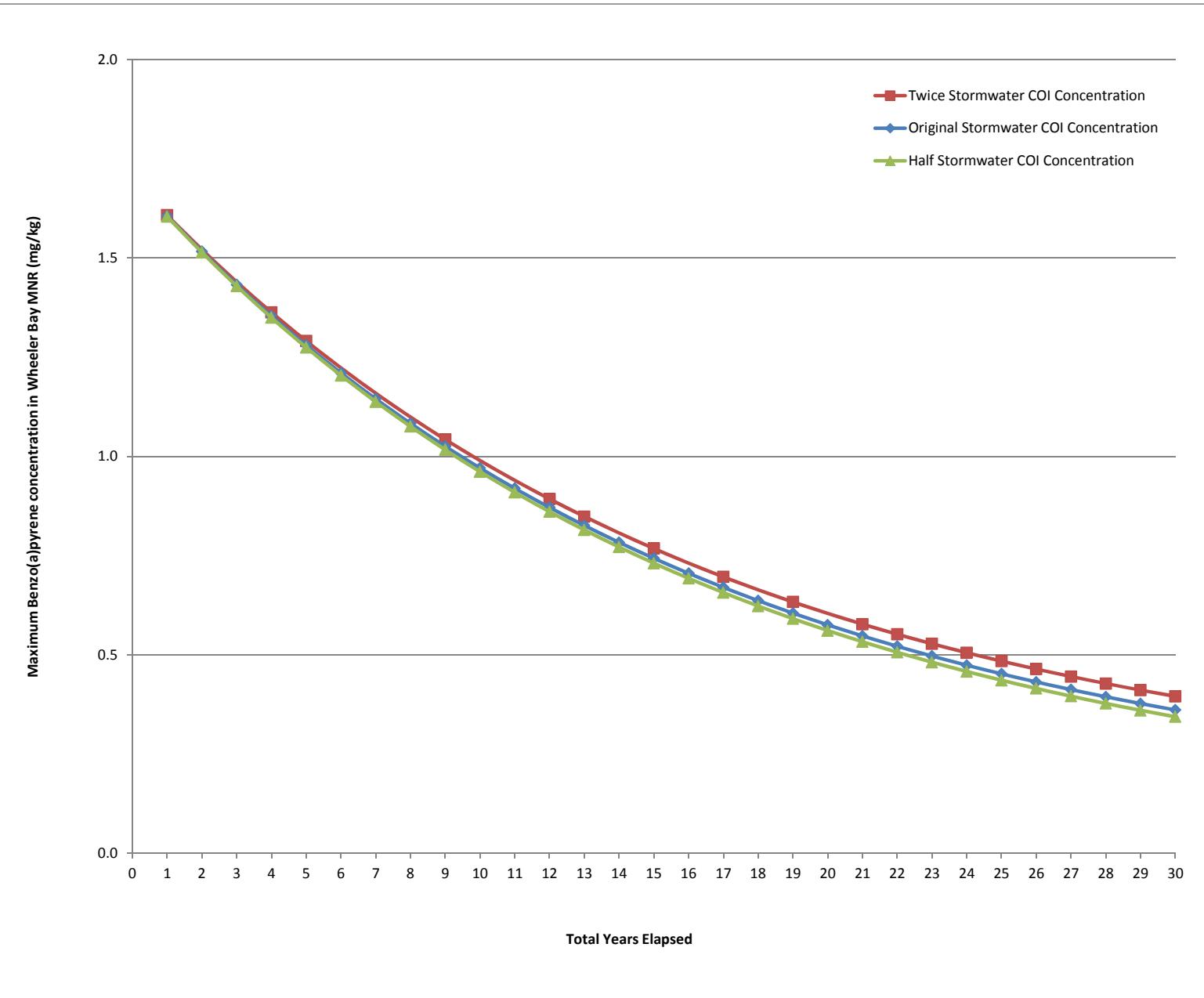
Benzo(a)pyrene

FROM MAX

Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Maximum concentration of Benzo(a)pyrene at any	1.60421	1.51411	1.42936	1.34964	1.27465	1.20412	1.13777	1.07536	1.01666	0.96144	0.90949	0.86064	0.81468	0.77145	0.73079	0.69254	0.65656	0.62272	0.59088	0.56094	0.53277	0.50628	0.48136	0.4579	0.43587	0.4151	0.39561	0.37726	0.36	0.3438 mg/kg
Mixing Layer thickness, ML	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15 cm	
Mass/Area, Rs	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918 g/cm ²		
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹	
Initial Concentration, Co	1.7	1.60421	1.51411	1.42936	1.34964	1.27465	1.20412	1.13777	1.07536	1.01666	0.96144	0.90949	0.86064	0.81468	0.77145	0.73079	0.69254	0.65656	0.62272	0.59088	0.56094	0.53277	0.50628	0.48136	0.4579	0.43587	0.41512	0.39561	0.3773	0.36 ug/kg
Input Concentration, Cp	0.08648	0.08648	0.08648	0.08648	0.08648	0.08648	0.08648	0.08648	0.08648	0.08648	0.08648	0.08648	0.08648	0.08648	0.08648	0.08648	0.08648	0.08648	0.08648	0.08648	0.08648	0.08648	0.08648	0.08648	0.08648	0.08648	0.08648	0.08648	0.0865 ug/kg	
Time step elapsed, t	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1 yr	
Ts = ML/Rs	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399		
1+kTs	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
e ^{-(1+kTs)t/Ts}	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064		
Spring 2010 PRG for Lead	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3		

Assumes mixing occur in 15cm (~half a foot).

Total load of COPC	0.01438 kg/yr
Total load of sediment	166306 kg/yr
Concentration of input	0.08648 mg/kg
Rs = mass/area	0.918 g/cm ²
Total Area	195000 ft ²
Total Mass Load	166306 kg/yr



Appendix C: Sensitivity Analysis Model Outputs
Wheeler Bay MNR Area - Benzo(a)pyrene - Varying TSS Load

Estimate recontamination in Wheeler Bay MNR

Area - ORIGINAL TSS LOAD		Benzo(a)pyrene		FROM MAX																											
Total years elapsed:		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Maximum concentration of Benzo(a)pyrene at any point in Wheeler Bay MNR, $C_c(t)$		1.61	1.52	1.43	1.35	1.28	1.21	1.14	1.08	1.03	0.97	0.92	0.87	0.83	0.78	0.74	0.71	0.67	0.64	0.60	0.58	0.55	0.52	0.50	0.47	0.45	0.43	0.41	0.39	0.38	0.36 mg/kg
Mixing Layer thickness, ML	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00 cm	
Mass/Area, R_s	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92 g/cm ²
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹	
Initial Concentration, C_0	1.7	1.6	1.5	1.4	1.4	1.3	1.2	1.1	1.1	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4 ug/kg		
Input Concentration, C_p	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1 ug/kg		
Time step elapsed, t	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00 yr		
Ts = ML/R _s	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34		
1+kTs	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
e ^{-(1+kTs)t/Ts}	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	
Spring 2010 PRG for Lead	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91			
Total load of COPC	0.018 kg/yr																														
Total load of sediment	166,306 kg/yr																														
Concentration of input	0.11 mg/kg																														
Rs = mass/area	0.918 g/cm ²																														
Total Area	195,000 ft ²																														
Total Mass Load	166,306 kg/yr																														

Assumes mixing occur in 15cm (~half a foot).

Estimate recontamination in Wheeler Bay MNR

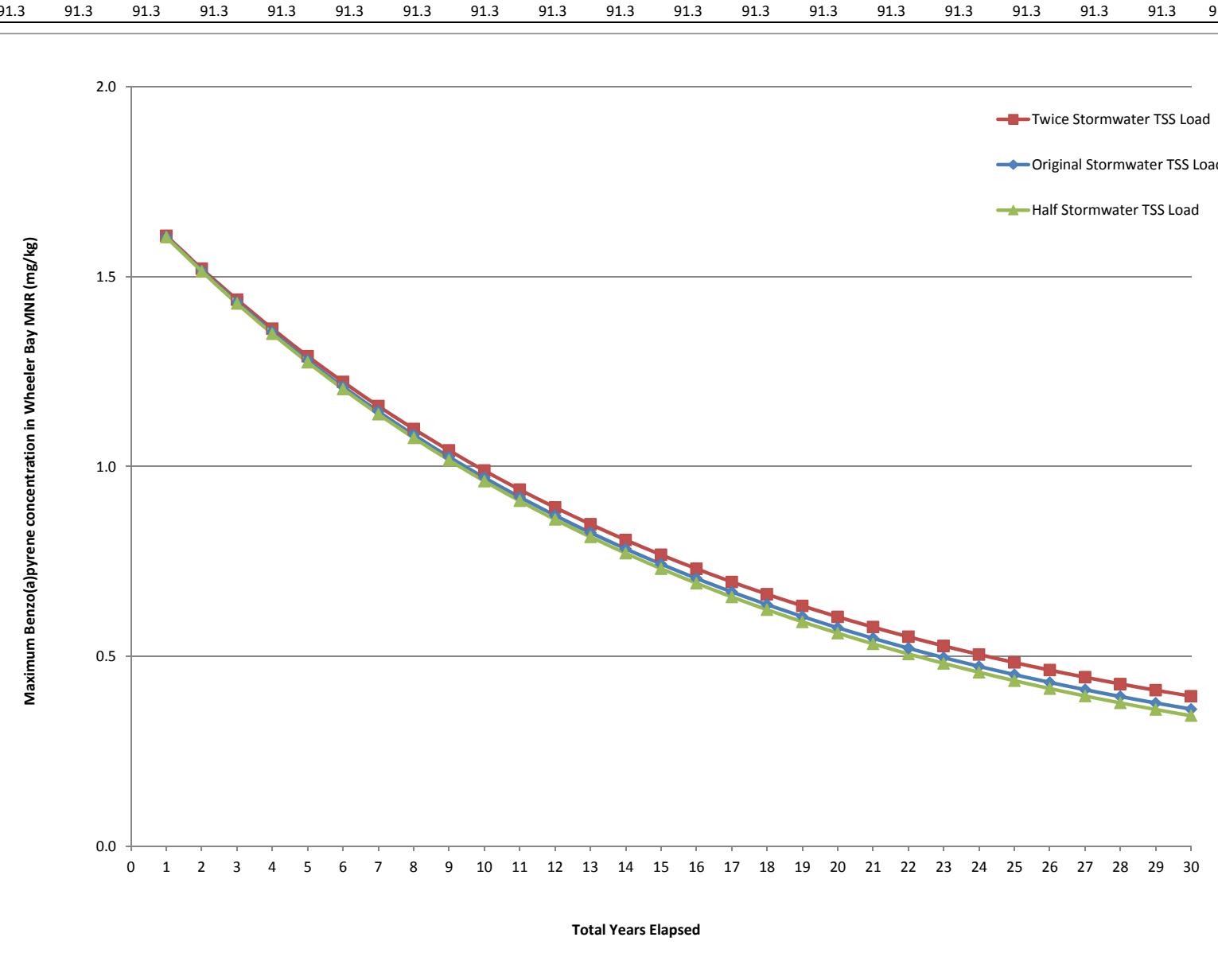
Area - TWICE TSS LOAD		Benzo(a)pyrene		FROM MAX																											
Total years elapsed:		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Maximum concentration of Benzo(a)pyrene at any point in Wheeler Bay MNR, $C_c(t)$	1.60785	1.52116	1.43962	1.36293	1.29078	1.22292	1.15909	1.09904	1.04257	0.98944	0.93947	0.89246	0.84825	0.80666	0.76753	0.73074	0.69612	0.66356	0.63294	0.60413	0.5										

Appendix C: Sensitivity Analysis Model Outputs
Wheeler Bay MNR Area - Benzo(a)pyrene - Varying TSS Load

Estimate recontamination in Wheeler Bay MNR

Area - HALF TSS LOAD	Benzo(a)pyrene		FROM MAX																													
Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs		
Maximum concentration of Benzo(a)pyrene at any	1.60422	1.51413	1.42938	1.34967	1.27469	1.20416	1.13781	1.07541	1.01671	0.96149	0.90955	0.8607	0.81475	0.77152	0.73086	0.69261	0.65664	0.6228	0.59097	0.56102	0.53286	0.50637	0.48145	0.458	0.43596	0.4152	0.39571	0.37736	0.3601	0.3439 mg/kg		
Mixing Layer thickness, ML	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15 cm		
Mass/Area, Rs	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918 g/cm ²			
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹		
Initial Concentration, Co	1.7	1.60422	1.51413	1.42938	1.34967	1.27469	1.20416	1.13781	1.07541	1.01671	0.96149	0.90955	0.8607	0.81475	0.77152	0.73086	0.69261	0.65664	0.6228	0.59097	0.56102	0.53286	0.50637	0.48145	0.458	0.43596	0.4152	0.39571	0.3774	0.3601 ug/kg		
Input Concentration, Cp	0.0866	0.0866	0.0866	0.0866	0.0866	0.0866	0.0866	0.0866	0.0866	0.0866	0.0866	0.0866	0.0866	0.0866	0.0866	0.0866	0.0866	0.0866	0.0866	0.0866	0.0866	0.0866	0.0866	0.0866	0.0866	0.0866	0.0866	0.0866	0.0866 ug/kg			
Time step elapsed, t	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1 yr		
Ts = ML/Rs	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399	16.3399			
1+kTs	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
e^{-(1+kTs)t/Ts}	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064	0.94064			
Spring 2010 PRG for Lead	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3			
Total load of COPC	0.0144 kg/yr																															
Total load of sediment	166306 kg/yr																															
Concentration of input	0.0866 mg/kg																															
Rs = mass/area	0.918 g/cm ²																															
Total Area	195000 ft ²																															
Total Mass Load	166306 kg/yr																															

Assumes mixing occur in 15cm (~half a foot).



Appendix C: Sensitivity Analysis Model Outputs

Wheeler Bay MNR Area - Benzo(a)pyrene - Varying Mixing Layer Thickness

Estimate recontamination in Wheeler Bay MNR

Area - Original Mixing Thickness 15 cm **Benzo(a)pyrene** **FROM MA.**

Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Maximum concentration of Benzo(a)pyrene at any point in Wheeler Bay MNR, $C_c(t)$	1.61	1.52	1.43	1.35	1.28	1.21	1.14	1.08	1.03	0.97	0.92	0.87	0.83	0.78	0.74	0.71	0.67	0.64	0.60	0.58	0.55	0.52	0.50	0.47	0.45	0.43	0.41	0.39	0.38	0.36 mg/kg
Mixing Layer thickness, ML	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00 cm	
Mass/Area, R_s	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92 g/cm ²	
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹	
Initial Concentration, C_0	1.7	1.6	1.5	1.4	1.4	1.3	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.7	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4 ug/kg	
Input Concentration, C_p	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1 ug/kg	
Time step elapsed, t	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00 yr		
Ts = ML/R _s	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	16.34	
1+kTs	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
e ^{-(1+kTs)t/Ts}	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94		
Spring 2010 PRG for Lead	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91		
Total load of COPC	0.018 kg/yr																													
Total load of sediment	166,306 kg/yr																													
Concentration of input	0.11 mg/kg																													
R_s = mass/area	0.918 g/cm ²																													
Total Area	195,000 ft ²																													
Total Mass Load	166,306 kg/yr																													

Assumes mixing occur in 15cm (~half a foot).

Estimate recontamination in Wheeler Bay MNR

Area - Mixing Thickness 10 cm **Benzo(a)pyrene** **FROM MA.**

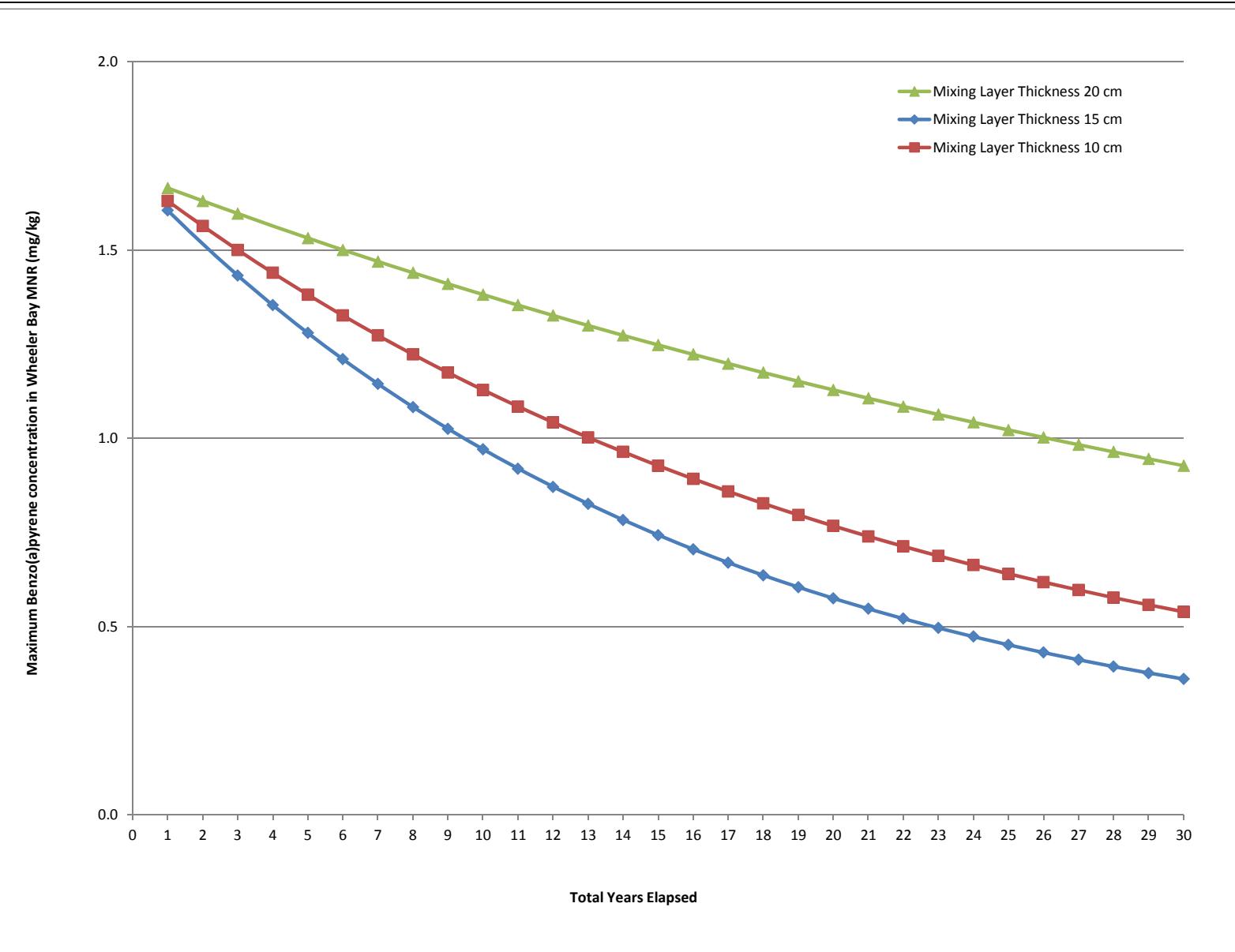
Appendix C: Sensitivity Analysis Model Outputs
Wheeler Bay MNR Area - Benzo(a)pyrene - Varying Mixing Layer Thickness

Estimate recontamination in Wheeler Bay MNR

Area - Mixing Thickness 20 cm Benzo(a)pyrene FROM MAX

Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Maximum concentration of Benzo(a)pyrene at any	1.62853	1.56027	1.49507	1.4328	1.37332	1.3165	1.26224	1.21041	1.16091	1.11362	1.06846	1.02533	0.98413	0.94477	0.90719	0.87129	0.837	0.80425	0.77296	0.74308	0.71455	0.68729	0.66125	0.6364	0.61263	0.5899	0.56828	0.54758	0.5278	0.5089 mg/kg
Mixing Layer thickness, ML	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20 cm
Mass/Area, Rs	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918 g/cm ²	
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹	
Initial Concentration, Co	1.7	1.62853	1.56027	1.49507	1.4328	1.37332	1.3165	1.26224	1.21041	1.16091	1.11362	1.06846	1.02533	0.98413	0.94477	0.90719	0.87129	0.837	0.80425	0.77296	0.74308	0.71455	0.68729	0.66125	0.63639	0.6126	0.58995	0.56828	0.5476	0.5278 ug/kg
Input Concentration, Cp	0.10695	0.10695	0.10695	0.10695	0.10695	0.10695	0.10695	0.10695	0.10695	0.10695	0.10695	0.10695	0.10695	0.10695	0.10695	0.10695	0.10695	0.10695	0.10695	0.10695	0.10695	0.10695	0.10695	0.10695	0.10695	0.10695	0.10695	0.10695	0.10695	0.107 ug/kg
Time step elapsed, t	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1 yr
Ts = ML/Rs	21.7865	21.7865	21.7865	21.7865	21.7865	21.7865	21.7865	21.7865	21.7865	21.7865	21.7865	21.7865	21.7865	21.7865	21.7865	21.7865	21.7865	21.7865	21.7865	21.7865	21.7865	21.7865	21.7865	21.7865	21.7865	21.7865	21.7865	21.7865		
1+kTs	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
e^{(-1+kTs)t/Ts)	0.95514	0.95514	0.95514	0.95514	0.95514	0.95514	0.95514	0.95514	0.95514	0.95514	0.95514	0.95514	0.95514	0.95514	0.95514	0.95514	0.95514	0.95514	0.95514	0.95514	0.95514	0.95514	0.95514	0.95514	0.95514	0.95514	0.95514	0.95514	0.95514	
Spring 2010 PRG for Lead	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	

Total load of COPC	0.01779 kg/yr
Total load of sediment	166306 kg/yr
Concentration of input	0.10695 mg/kg
Rs = mass/area	0.918 g/cm ²
Total Area	195000 ft ²
Total Mass Load	166306 kg/yr



Appendix C: Sensitivity Analysis Model Outputs

Wheeler Bay MNR Area - Benzo(a)pyrene - Varying Sedimentation Rate

Estimate recontamination in Wheeler Bay MNR

Assumes mixing occur in 15cm (~half a foot).

Estimate recontamination in Wheeler Bay MNR

Assumes mixing occurs in 15 cm (\sim half a foot)

Appendix C: Sensitivity Analysis Model Outputs
Wheeler Bay MNR Area - Benzo(a)pyrene - Varying Sedimentation Rate

Estimate recontamination in Wheeler Bay MNR

Area - Half the Sedimentation Rate

Benzo(a)pyrene

FROM MAX

Total years elapsed:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30 yrs
Maximum concentration of Benzo(a)pyrene at any	1.65322	1.60785	1.56384	1.52116	1.47977	1.43962	1.40069	1.36293	1.3263	1.29078	1.25633	1.22292	1.19052	1.15909	1.12861	1.09904	1.07037	1.04257	1.0156	0.98944	0.96407	0.93947	0.9156	0.8925	0.87002	0.8482	0.82713	0.80666	0.7868	0.7675 mg/kg
Mixing Layer thickness, ML	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15 cm	
Mass/Area, Rs	0.459	0.459	0.459	0.459	0.459	0.459	0.459	0.459	0.459	0.459	0.459	0.459	0.459	0.459	0.459	0.459	0.459	0.459	0.459	0.459	0.459	0.459	0.459	0.459	0.459	0.459	0.459	0.459	0.459 g/cm ²	
Degradation Rate, k	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 yr ⁻¹	
Initial Concentration, Co	1.7	1.65322	1.60785	1.56384	1.52116	1.47977	1.43962	1.40069	1.36293	1.3263	1.29078	1.25633	1.22292	1.19052	1.15909	1.12861	1.09904	1.07037	1.04257	1.0156	0.98944	0.96407	0.93947	0.9156	0.89246	0.87	0.84825	0.82713	0.8067	0.7868 ug/kg
Input Concentration, Cp	0.14766	0.14766	0.14766	0.14766	0.14766	0.14766	0.14766	0.14766	0.14766	0.14766	0.14766	0.14766	0.14766	0.14766	0.14766	0.14766	0.14766	0.14766	0.14766	0.14766	0.14766	0.14766	0.14766	0.14766	0.14766	0.14766	0.14766	0.14766 ug/kg		
Time step elapsed, t	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1 yr	
Ts = ML/Rs	32.6797	32.6797	32.6797	32.6797	32.6797	32.6797	32.6797	32.6797	32.6797	32.6797	32.6797	32.6797	32.6797	32.6797	32.6797	32.6797	32.6797	32.6797	32.6797	32.6797	32.6797	32.6797	32.6797	32.6797	32.6797	32.6797	32.68			
1+KTs	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
e ^{-(1+KTs)t/Ts}	0.96986	0.96986	0.96986	0.96986	0.96986	0.96986	0.96986	0.96986	0.96986	0.96986	0.96986	0.96986	0.96986	0.96986	0.96986	0.96986	0.96986	0.96986	0.96986	0.96986	0.96986	0.96986	0.96986	0.96986	0.96986	0.96986	0.96986	0.96986		
Spring 2010 PRG for Lead	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3	91.3			
Total load of COPC	0.01228 kg/yr																													
Total load of sediment	83152.9 kg/yr																													
Concentration of input	0.14766 mg/kg																													
Rs = mass/area	0.459 g/cm ²																													
Total Area	195000 ft ²																													
Total Mass Load	83152.9 kg/yr																													

Assumes mixing occur in 15cm (~half a foot).

